THE GLASS INDUSTRY

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THE FIGHT AGAINST WASTAGE OF HEAT IN GLASS FURNACES

By IVAN PEYCHES, D. Sc.

Director of Research of the Saint-Gobain Glass Company

TRANSLATED FROM THE BULLETIN DE L'INSTITUT DU VERRE (PARIS) FOR SEPTEMBER, 1946

By F. W. PRESTON

PART I

Translator's Note: There are a few references, social rather than technological in character, which I have omitted altogether since no corresponding Anglo-Saxon situation exists. Taken by and large, the translation is a fairly literal one, but I have used somewhat free translations occasionally where that seemed likely to introduce greater clarity. At the end I have added a glossary of French terms relating to glass-working which occur in the article, and are not translated correctly, or at any rate in the idiom of the shop, in the technical or other French dictionaries available to me.

One important decision had to be made in this translation, namely, whether to leave the calculations and numerical values in French units or to convert into American or British units. I decided, in most cases, to retain the French figures on the grounds that there are some differences between English and American ways of expressing these quantities (for instance, a ton of glass in England weighs 2240 lb., and in America 2000 lb.) and there is also some difference between the practice of Corning and the rest of the United States (for instance, Corning uses Centigrade degrees and most other people use Fahrenheit degrees). There is no great difficulty in using the French units, or in making the conversion to the units preferred by the individual reader.

I have had some considerable talk and correspondence with Mr. D. E. Sharp of Libbey-Owens-Ford Co. about the meaning of some of the terms and the significance of the findings and wish here to acknowledge his assistance. Also, Mr. Glenn Lehr, one of Mr. Sharp's assistants, has done the bulk of the work in preparing the figures for the English version. This, also, we gratefully acknowledge.—F. W. P.

Abstract

The present article is in three parts: the first is devoted to the distribution of heat losses and the savings that may be affected by external arrangements such as insulation; the second goes more deeply into the manufacturing process and deals with convection currents which dissipate much heat; finally in the third part, the author seeks to uncover the basic principles which control the use of different sources of energy and gives his opinion on results obtained to date in the direction of a more logical use of temperature differentials.

PART I—Savings by the Intereception of Heat Losses

Determining where heat losses occur is a commonsense operation practiced for many years in every major industry which has adequate apparatus, and is summed up in the "heat-balance".

By way of illustration, we give here two typical heat-balances for glass furnaces: the first relating to a furnace making plate or drawn sheet glass with a daily production of some forty tonnes*; the second relating to a bottle glass furnace with a daily production of about twenty tonnes (Figures 1 and 2).

These heat-balances, presented here in a very simplified form, are sufficient to draw attention to the important points of waste: the stack, and the losses from the furnace itself, evidently the spectacular element of the system.

So far as the stack is concerned, we shall say nothing further, leaving to others better qualified than ourselves the task of dealing with this subject which of itself would be enough to occupy a whole session.** We may

*Translator's note: The French tonne is 1,000 kilograms or 2,205 lb., quite close to the English long ton, and about 10% more than the American ton.

**Translator's note: The original French article was presented at a conference of the "Maison de la Chimie" on March 22, 1946.

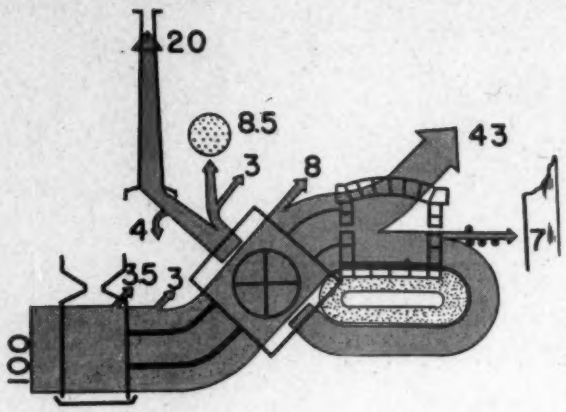


Fig. 1

note, nonetheless, on the heat balance (Fig. 1) the very appreciable effect of a heat economizer.

We shall devote all our attention to the losses of the furnace proper. We have chosen two very different examples, relating to very different manufacturing operations, and hence to differing qualities of glass. We see that the furnace intended for quality glass is more wasteful than the bottle glass furnace. The efficiency of the furnace alone is 7/50 or say 14%, while that of the furnace in Figure 2 is 16.5/41.5, or say 40%. This increase of efficiency is naturally reflected in the over-all heat balance in the fact, well known to glass makers, that the plate glass or window glass tank of an average size requires more than one pound of coal per pound of glass produced, while the consumption of the bottle tank is in the neighborhood of 0.5 to 0.6 lb. We shall see later the underlying cause of this difference, which cannot be explained solely by recognizing that the quality is not identical.

Let us take a closer look at the losses from the furnace.

The orthodox heat-balances are of value, it is true, but altogether insufficient. It is not enough to know how many calories are put in at the entrance to the passageways, and to figure at each later point thereof how many of them are still passing, in order to have a clear understanding of the circumstances overcome en route. These heat balances are in effect based on analyses and temperature measurements of gas, products of combustion, soot, etc., and the losses are attributed to radiation—little is said of convection—all of which in fact is pretty vague.

Having had occasion to concern ourselves with *electric* glass furnaces, we found ourselves considerably embarrassed in determining the heat balance, since the only measurable item was the trifling energy really used by the glass, while all the rest was precisely that "radiation loss", so easily obtained in an orthodox heat balance by subtracting from 100%.

On the advice of Professor Ribaud and thanks to a piece of apparatus which he was good enough to put at our disposal, we undertook to determine these losses directly, and obtained in 1937 the first over-all heat balance on a large industrial furnace; a balance which came out so exactly that at first we ascribed it to a fortunate accident.

Subsequently, different over-all heat balances that we had occasion to make caused us to realize that the method employed was sufficiently exact that the figures could be taken literally. The *Centre d'Etudes Thermiques* published over the signature of R. Martin in 1940[1] an over-all heat balance of a metallurgical furnace, without doubt a little less complete than those which we practiced, since convection is not measured directly therein, but it may serve as an excellent illustration of what we are about to say.

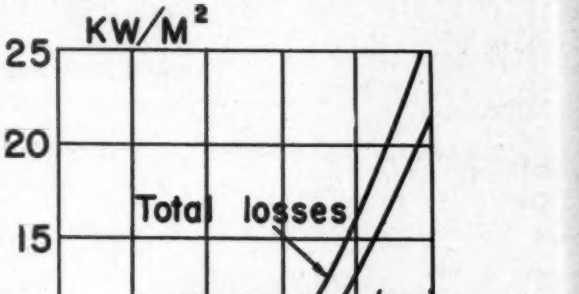


Fig. 3

Any furnace engineer can, starting with the thermal constants of the refractory materials, calculate from first principles what ought to be the heat losses from a furnace operating under a given temperature regime. However, many sources of error intervene, of which it is rarely possible to take precise account. The thermal conductivity, K, of the material is determined under strictly defined conditions, upon clean blocks, with parallel heat flux. What does it become after some months of service when the refractory is recrystallized—which changes the real value of K—, cracked—which modifies the course of the lines of heat flow—, worn—which

1. R. Martin, Bilans thermiques de fours Martin, Actualités Scientifiques et Industrielles, n° 865 (Hermann, 1940).

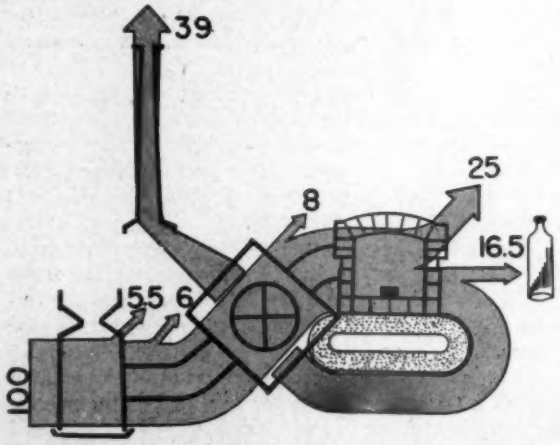


Fig. 2

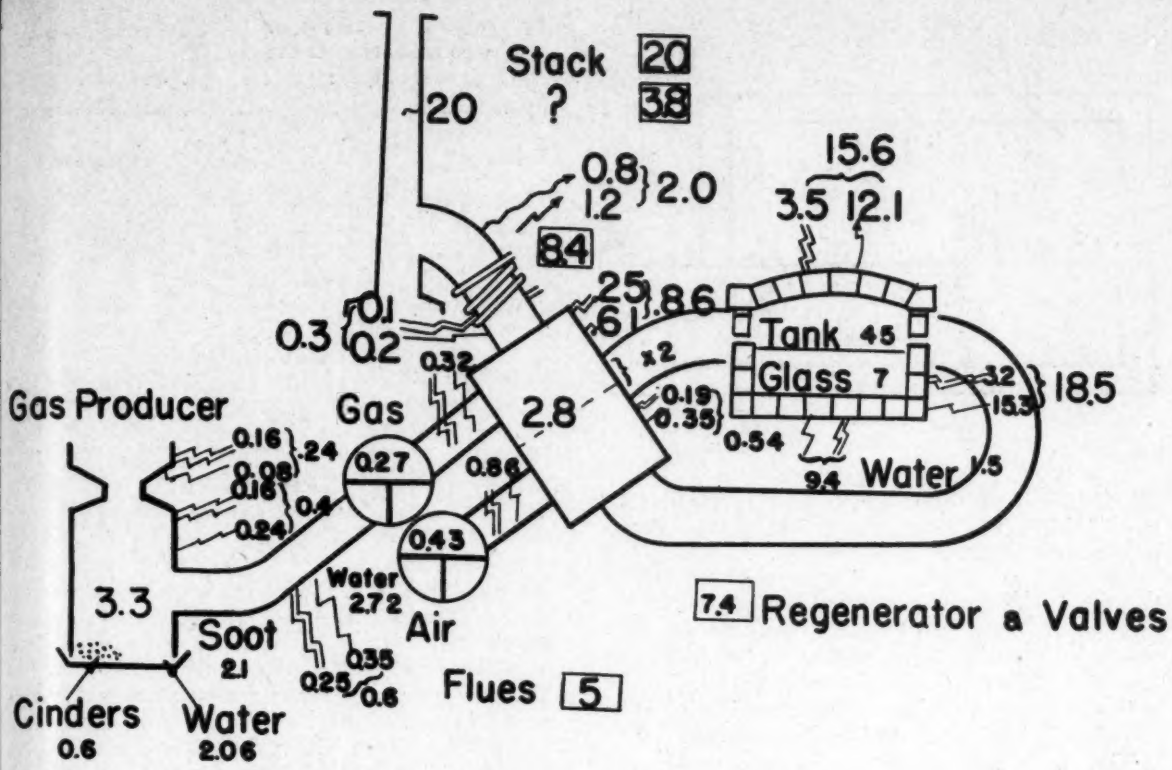


Fig. 4

changes the effective thickness? Knowledge of the temperature on the outside surface of the furnace permits in theory a determination of the quantity of heat carried off by radiation and that carried away by convection, and Figure 3 below shows how these two actions vary as a function of the surface temperature; but what is the effect, on these values, of the irregular contours of industrial furnaces, of the "fin" effects of steel work and buckstays? The theory of natural convection for large surfaces is itself still to be worked out. Furnace engineers introduce large corrections to their theory by means of empirical coefficients.

For all these reasons, the determination of losses is an experimental job which ought to be done on the spot and to be attacked directly on the scale involved, discarding as far as possible all calculations resting on hypothetical values.

To measure convection we used an apparatus called a "thermoanemometer", in which a sensitive anemometer is combined with a thermocouple carefully protected from direct radiation by suitable screens.

When all corrections have been made, this apparatus gives the velocity and the temperature of the convected air. The field of convection is explored point by point, and furnishes a diagram from which there is readily deduced the quantity of heat carried away by convection.

To measure the radiation we use a Moll thermopile, protected by a water jacket, the type more particularly studied at the Gas Laboratory of Paris by Gouffé, and frequently described since. The radiation is obtained directly without indulging in any guesses as to the emissivity. As a check, we also measure surface temperatures, using a contact thermocouple likewise developed by M. Gouffé at the Paris Gas Laboratory. A quick survey of the furnace will enable us to divide it into a certain number of zones, at the center of each of which the measurements will be made.

The number of these zones—and hence the number of measurements to be taken—may be very much less than might at first be thought. For our first heat balances we were led to use temperature measurements of the walls at more than three hundred points. Later, we very greatly reduced that number; and the exploration of a furnace can be done in two days, the study of a complete installation from the gas producer to the stack requiring a week.

The calculations themselves are fairly long but a few comments permit some simplification. Suppose we know nothing but the temperatures of the walls. It is not necessary to calculate radiation and convection for each point.

Convection varies as the 5/4 power of the difference of temperature between the wall and its surroundings, which is sufficiently close to a linear law. If the temperature varies but little from one point to another, it is evidently permissible to take the mean temperature for purposes of calculation. But radiation varies as the differences of the fourth powers of the temperatures, and one would hesitate to make a single calculation on the same average temperature. Nonetheless, this is perfectly legitimate.[2]

2. We have to compare the approximate expression $W' = a\left[\left(\frac{T_1+T_2}{2}\right)^4 - T_0^4\right]$ with the complete formulation $W = a\left[\frac{(T_1^4 - T_0^4) + (T_2^4 - T_0^4)}{2}\right]$. Let us put $T_2 = T_1 + \varepsilon$, ε being small. After legitimate approximations neglecting terms involving $\frac{\varepsilon^2}{T^2}$ and finally the term $\frac{4\varepsilon}{T_1}$, we find $\frac{W'}{W} = 1 - \frac{3}{2}\left(\frac{\varepsilon}{T_1}\right)^2$.

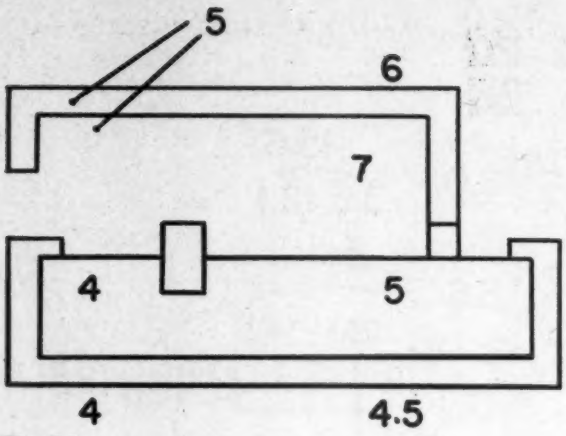


Fig. 5

The error is no more than 5% if the temperature interval is 500 to 600° absolute, and 5.5% if the temperature interval is 1400 to 1700° absolute.

We construct in this fashion a sort of external heat-balance which, so far from being opposed to the orthodox treatment, which we may consider as an internal heat-balance, really confirms and completes it. By this means we are able to write on the heat-balance of Figure 1 alongside each part of the installation, where and how the heat units have been lost (Fig. 4).

What then are the results afforded us by working out these balances? The tank of a glass furnace contains molten glass at very different temperatures. Whereas in the melting and fining zone there is observed, with flint glass, 1450° C. at the surface and 1300° C. on the bottom blocks at about one meter depth, in the working end the temperature is much more uniform in a vertical direction and remains of the order of 1100° C. (1000 to 1200° C., depending on the manufacturing procedure). The fire space itself, where the gas is burnt, nowadays exceeds 1500° C. We may therefore expect great variations in the losses from one point to another of the furnace.

As an example of the sort of temperatures met with on the furnace walls, we may indicate:

Sidewall blocks of clay one foot thick (new furnace):

Melting end	Sidewalls near the top: 250-300° C.	
	Sidewalls near the bottom: 220-250° C.	
	Bottom blocks: 170-180° C.	
Working end	Sidewalls: 200° C.	
	Bottom blocks: 160° C.	

Silica roof one foot thick: 300° C.

With a worn furnace these temperatures naturally rise and may exceed, for the tank proper: 350° C.

In order to get an idea as to the order of magnitude of the heat losses which these temperatures involve, let us announce forthwith that, for a furnace whose surroundings are at 27° C. in calm air, a vertical sidewall at a mean temperature of 250° C. loses:

By radiation (assuming an average emissivity for the refractories of 0.8):	3 kw. per square meter
By convection:	1.7 kw. per square meter
Total:	4.7 kw. per square meter

These theoretical values are calculated from the laws of Stefan and Lorenz-Langmuir. In practice, every time a direct measurement of convection was made, we found values appreciably higher than those given by the Lorenz-Langmuir formula, or by the more accurate and very recent formulae of the Convection Commission of Heat Engineers.* The limits within which these formulae are valid are in fact frequently exceeded in the concrete instances of glass furnaces. Furthermore, and this is undoubtedly one of the more important sources of error, glass tanks are generally built over a basement, with a wide space surrounding the tank, so that the natural convection between the basement and the working floor is superposed on that of the furnace alone and amounts to a forced ventilation.

We give below (Fig. 5), the losses per square meter which we have been led to adopt in the course of our measurements—and these do not differ very significantly from those to which calculation would lead us.

They are given in kilowatts per square meter,** because the figures are easier to remember. Multiplying by 860 gives the losses in kilocalories per hour per square meter, or dividing by ten gives them in watts per square centimeter.

The figures relate to a new furnace, of good grade flux blocks one foot thick and silica brick also one foot thick. At the end of a run, the furnace losses are increased by 20 to 25%.

By way of example, let us calculate the losses from a standard bottle furnace having a melting area six meters by four, a depth of one meter, a combustion space one meter high under the springings of the arch, and a working end two and one-half meters by four.

To be rigorous, we ought to take into account the thickness of the refractories, calculate the internal and external surfaces, and apply our coefficients to the mean surface. However, since at the moment we are only concerned, by way of illustration, to obtain an order of magnitude, we shall neglect this complication and just add 10% to our results.

TABULATION FROM P.5 OF ORIGINAL

		Melting End	Working End
Tank Proper	Sidewall Blocks	20 sq.m. x 5 = 100	13 sq.m. x 4 = 52
	Bottom Blocks	24 " x 4.5 = 108	10 " x 4 = 40
Superstructure	Sidewalls	20 sq.m. x 7 = 140	13 sq.m. x 5 = 65
	Roof	24 " x 6 = 144	10 " x 5 = 50
		492	207

Total (in round figures)	700	
Allowance for wall thickness, as per text	70	(= 10%)
Allowance for working apertures and	115†	(= 15%)
	885 kw.	

*Translator's note: "Commission de convection du Groupement des thermiciens." Evidently some French organization.

**Translator's note: Dr. Peyches frequently writes kwh (kilowatt-hours) in place of kilowatts, on the ground that he is talking about kilowatt-hours per hour; but since this is cumbersome, and, I think, confusing, I have assumed responsibility for writing it in a more normal way. The peculiar expression occurs many times in the original French version, but not consistently. I hope I have succeeded in achieving consistency in the translation.

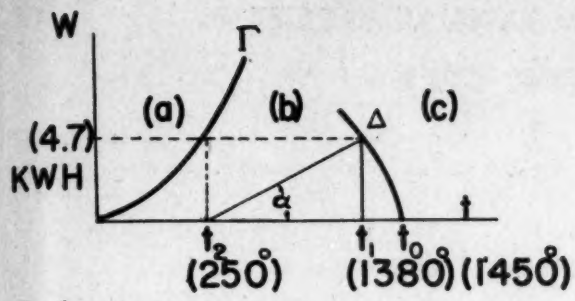


Fig. 6

Such a furnace will easily melt one tonne of glass per square meter of melting area per day, or say 24 tonnes per day, or one tonne per hour. The energy required for melting is around 0.6 kilowatt hours per kilogram of glass, taking into account the heat required for raising the batch material to temperature, the heat required for the reaction, and the heat restored by the cooling off process in the working end.

The total energy or, more correctly, power required for melting is therefore around 600 kilowatts.

Hence, in the furnace alone, out of 1485 kilowatts introduced, 800 are lost and only 600 are useful. The efficiency of the furnace alone, therefore, is about 40%. This corresponds exactly with Figure 2.

We emphasize once more that these figures are given merely by way of illustration. Nonetheless, we shall retain them and constantly refer to them in what follows.

What can be done then with the furnace to save heat? The idea of insulation—which springs immediately to mind when speaking of heat losses—is tempting, but dangerous. The bath of glass at high temperature is extremely corrosive upon the refractories. While a set of bottom blocks in contact with glass at 1,300° C. holds up readily for several years, the flux line in contact with the hottest glass is severely eaten away after a few months' operation and may have to be repaired in the course of the run.* To insulate the refractories in such zones would increase the attack by the glass which would not be chilled sufficiently in contact with the sidewall.

In order to understand more perfectly than by intuition, the behavior of insulation or of cooling air on this contact between glass and refractory, it is necessary for us to have a means of depicting it which is simple and yet sufficiently precise.

We shall adopt the graphical representation used by Heymes of the Heat Testing Laboratory of the Saint-Gobain Glass Company.

We gave a short while back the curve of radiation losses as a function of temperature along with the curve of convection losses. Assuming a mean emissivity of 0.8 for the refractories, and supposing further that the sidewall is vertical and in contact with calm air, we can trace the curve giving the total losses W per unit area at each temperature.

Let Γ be this curve in Figure 6.

If, further, we establish the equation of heat exchange by conduction through the refractory block, we shall write:

$$W = \frac{K}{e}(t_1 - t_2)$$

t_1 and t_2 being respectively the internal and external temperatures of the black whose conductivity is K and thickness e.

K/e is a property of the block and may be set equal to tan α. The equation may be represented by the rectangle erected on W and $t_1 - t_2$ and having as its diagonal a line drawn at an angle α (see Fig. 6). Call this rectangle R.

If the glass in contact with the flux block gives up heat to this block under steady conditions, it can only be because the glass is constantly receiving, from the regions at maximum temperature, the necessary energy.

It is for this reason that the transverse isotherms are curved with the concave side facing upwards.

Let t_0 be the maximum temperature, which may nonetheless be effective over a large part of the center of the furnace. The energy drained towards the flux blocks may pass by means of conduction, convection, and reradiation. Each one of these elements is at present inaccessible to experimentation, but McCauley[3] has worked out an over-all conductivity such that, under a temperature difference $t_0 - t_1$, it passes an amount of energy W.

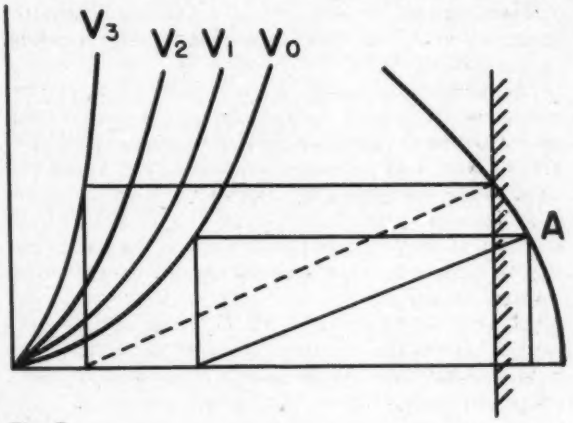


Fig. 7

In Figure 6, let Δ be the curve for this energy as a function of $t_0 - t_1$.

Since all the energy lost by the flux block has been communicated to it by the glass, we have to express the fact that the three values of W are identical. Graphically, this involves a construction such that the rectangle R can be located exactly between the two curves Γ and Δ drawn to the same scale of temperature.

Furnished with the graphical representation, we now find ourselves in a better position to assess the part played by the nature of the refractory, of the insulation, or of the cooling air.

The principal anxiety of the glass maker is to reduce wear on the tank, so as to prolong the run of production. Let us see then the different tactics to which he may have recourse.

Two temperatures are fixed by the nature of things: that of the furnace room, which determines the curve Γ

(*Continued on page 102*)

†Translators note. (Preceding page.) Dr. Long informs me that while the 10% is calculated on the 700, the 15% is calculated on the 770, which explains what otherwise looks like an error of arithmetic.

*Translator's note: It is evident that the author figures on a separate course of refractories at the flux line and proposes to replace these blocks with others during the run. In American practice, it is rare indeed to have a separate course of blocks, for except for hot patching, we simply run until the whole sidewall must be replaced.

3. McCauley, Journal Amer. Cer. Soc., viii, 1925, 493.

A. C. S. TO HOLD 49th ANNUAL MEETING IN ATLANTIC CITY

The forty-ninth Annual Meeting of the American Ceramic Society will convene in Atlantic City, New Jersey, on Sunday, April 20. Registration will take place Sunday afternoon and Monday in the lobby of the Hotel Traymore and all meetings of the various Divisions will be held Tuesday through Thursday at Convention Hall.

The pattern of this meeting will be somewhat changed from those in the recent past in that Monday will not be devoted to a General Session. That part of the convention program which can be considered in the General Session category will take place Tuesday forenoon. Scheduled for this session is a lecture: Color, What Is It? by Isay A. Balinkin, Department of Physics, University of Cincinnati, and the Edward Orton, Jr., Fellow Lecture: Integration in Science, Education and Society by Ralph E. Gibson, Applied Physics Laboratory, Johns Hopkins University.

Also scheduled for Monday, the 21st, at the Hotel Traymore is the meeting of the Board of Trustees in the Belvedere Room. The Executive Committee Meeting, the Luncheon and the general meeting of the Institute of Ceramic Engineers will take place at the Traymore.

The Board of Trustees, Division Officers, Committee Chairmen and Local Section Chairmen dinner will be held at the same hotel.

The Ceramic Camera Club will have all entries on exhibition all week in the Corridor at Convention Hall. As usual, the Frazier Award for the outstanding photographic print will be presented, the Vontury Award will be given for the best print in which a ceramic art object is an essential part of the picture and ribbons will be awarded to the two best pictures in the three divisions in which prints are classified, namely, Pictorial, Portrait and Industrial.

On Wednesday evening, April 23, the Annual banquet will be held in the American Room of the Hotel Traymore. At this time the President's report will be given, new officers inducted and new Fellows presented.

The highlight of the entertainment program will be the Boardwalk Night scheduled for Tuesday evening at Convention Hall. This is to take place following the school dinners and the President will receive the students of the ceramic schools.

After the reception, a variety revue will be presented. Howard Lanin, a well-known producer, who has put on some big affairs in the East and who was regularly retained by the larger steel producers in Pittsburgh, has been secured to stage this show for the members of the Society and guests. He will bring all-New York talent and, it is stated, will put on the finest night of entertainment that has ever been enjoyed by the attendants at an Annual Meeting of the Society.

Tickets will be issued without charge to all members who register and to the nonmembers who are guests of the Society at that time. Students will also receive tickets for this show. After the show, the dance orchestra will be retained and dancing will be in order for the remainder of the evening.

Space limitations prevent the publication in full of the Refractories Division program. However, there are two papers included in this program which should be of special interest to glassmen. Both of these papers will be presented Thursday forenoon. These papers are Comments on Clay Flux Block for Glass Furnaces by W. L. Fabianic, Owens-Illinois Glass Company, and Miniature Glass Tank for Glass-Attack Tests by J. C. McMullen, Carborundum Company.

Committee C-14 of the A.S.T.M. will meet Thursday afternoon, April 24, and a meeting to consider a "Proposal for a Third International Glass Congress" will follow. The regular daily program of Glass Division papers follows:

GLASS DIVISION PROGRAM

Tuesday Afternoon, April 22, 1947

2:30 P.M.-5:30 P.M.

Convention Hall

1. Transmission of Binary Glasses in Near Infrared. *By J. M. Florence, Francis W. Glaze, and C. H. Hahner: National Bureau of Standards, Washington 25, D. C.*

A study has been made of near infrared transmission of a number of binary glasses. Of the systems studied, the lithium silicates and lead silicates were found to have the highest transmission in the range of 3.0 to 5.0 microns. The transmissions of the lithium silicates are compared with those of the other alkali-silicate glasses. Transmission values are given for lead-silicate glasses of higher lead content than have previously been reported in the literature.

2. Staining of Glass Containers in Contact with Iron. *By Evelyn C. Marboe and W. A. Weyl: Glass Science, Incorporated, State College, Pa.*

A wet glass surface brought in contact with metallic iron acquires a brown stain which cannot be removed easily. This phenomenon was first observed by industry interested in the automatic washing of glass containers. A similar phenomenon can be observed with enamels.

A systematic study revealed that iron immersed in water, especially in the presence of minute amounts of chlorides, produces positively charged ions which go into solution. The metal therefore becomes negatively charged. A glass surface in contact with the iron acquires a negatively charged halo around the point of contact. This area attracts the positively charged ferric ions into the surface layer where their combination with the silica gel leads to a permanent stain of ferric hydrosilicate.

Reagents which produce anionic iron complexes will prevent staining.

3. Theory of Mechanism of Fracture of Glass. *By Nelson W. Taylor: Research Department, Minnesota Mining and Manufacturing Company, St. Paul 6, Minn.*

When a piece of glass having Young's modulus, E, is placed under a net tension, f, an immediate elongation occurs, and after a time, t, there is fracture. During this period, there may be no increase in length, but it is a mistake to assume that no internal rearrangement is occurring. Actually, some atomic rearrangement does take place, and $E\alpha/f$ measures its activation energy requirement. α is relatively small when moisture is present, because moisture weakens the bonds in the glass and thereby promotes rearrangement. Let λ_0 be the critical elongation required for fracture of the strongest bond: then $r = E\lambda_1/f$ is the length of the "unit prism" whose atoms must cooperate in order to produce this elongation. This leads to equation (1)

$$\text{Log } t = -\log k_0 + \frac{1}{f}\left(\frac{E\alpha}{2.3kT}\right) \qquad (1)$$

t = time for fracture (duration of constant stress, f).
k = Boltzmann constant.
T = absolute temperature.
α and k_0 = experimentally determined constants.

This expression has the same form as the Glathart-Preston empirical relation of equation (2) (see *Jour. Applied Phys.*, 17, 189 (1946)) which, in the case of the glass, appears to be valid over a time factor of 10^7.

$$\text{Log } t = -a/m + 1/fm \qquad (2)$$

4. Effect of Chemical Composition on Durability of Bottle Glass. *By H. E. Simpson: Department of Glass Technology, New York State College of Ceramics, Alfred, N. Y. (formerly of Mellon Institute, Pittsburgh 13, Pa.).*

The chemical durability of glass is a subject of extreme importance to all manufacturers of glass products, and the resistance to attack by moisture, alkalis, and acids is desirable.

A study of various methods of testing durability of glass revealed that no single method was completely satisfactory nor did any single test fully evaluate the glass.

Glass surfaces or samples, as received, were tested for attack by moisture as well as by acids and alkalis. Comparisons were made on a number of container glasses, a pressed-ware glass, and a borosilicate glass.

Attack by moisture was studied by exposing glass to high humidity (approximately 100%) at an elevated temperature (50° C.) for 30 days and by observing the resulting surface deterioration. Attack by alkali and acid, respectively, was measured by loss in weight in 2N caustic soda solution and constant-boiling hydrochloric acid.

It was found that Al_2O_3 up to 3.5% gave good resistance to attack by moisture; B_2O_3 was also quite helpful. The borosilicate glass was quite durable to attack by water and acid but poor in resistance to alkalis.

No great difference was noted in the weathering tendency of the inside and outside of the container. No definite relationship could be established between the chemical composition of the glasses and their resistance to attack by acid or alkali.

A review of the literature is given and various theories of weathering of glass are discussed.

Wednesday Forenoon, April 23, 1947

9:30 A.M.-12:30 P.M.

Convention Hall

5. Functions of Minor Constituents in Commercial Selenium-Ruby Batch. *By R. R. Shively and W. A. Weyl: Glass Science, Incorporated, State College, Pa.*

In addition to the chemicals essential to the formation of the colorant, the nature of which is well established, successful commercial selenium-ruby batches commonly contain a number of characteristic minor ingredients. These are zinc oxide, cryolite, or other fluorine compounds, bone ash, and minute amounts of copper or nickel oxide.

Laboratory experiments are described which helped to establish the functions of these minor constituents. Owing to the extreme insolubility of copper and nickel sulfide in silicate melts, these compounds form at high temperatures and provide nuclei for the cadmium sulfoselenide which requires a lower temperature for its formation.

Bone ash, especially in combination with fluoride, leads to a very insoluble phase, apatite, which enhances the striking of the selenium ruby.

Formation of cadmium sulfoselenide will not take place at high temperatures. Introducing fluorine into a silicate glass facilitates molecular rearrangements because of the weaker forces exerted by this monovalent anion as compared with divalent oxygen ions. Fluorides increase the low-temperature mobility of the glass and speed up the striking process.

Zinc oxide too increases the low-temperature mobility and favors striking, but its chief function consists in retaining sulfur and selenium in the melt.

Alkali sulfoferrite and selenoferrite produce a red-brown color, and their formation in glasses containing strong reducing agents, such as carbon, accounts for the deep color of some glasses containing only small amounts of cadmium sulfoselenide.

6. Effect of Heat-Treatments on Density of High-Silica Glasses. *By Arthur Q. Tool: National Bureau of Standards, Washington 25, D. C.*

In 1925, Tool and Eichlin (A. Q. Tool and C. G. Eichlin "Variations in Glass Caused by Heat-Treatment," *Jour. Amer. Ceram. Soc.*, 8 [1] 1-17 (1925)) called attention to the possibility that certain glasses containing a rather high percentage of silica, while at temperatures within their annealing ranges, are composed of a relatively rigid framework with its interstices filled by another component, glass, that still possesses a relatively high inelastic deformability. This possibility was suggested by certain peculiarities in the heating curves which show the exothermic and endothermic effects of these glasses. A study of the expansion curves obtained under a variety of conditions supported this view concerning the constitution of such glasses. All results since that time agree with this concept. In the present report, it will be pointed out that the density changes produced in these glasses by changing their heat-treatment also indicate that a high-silica glass is composed of two components that have widely different ranges of softening temperatures.

7. New Interpretation of Certain Discontinuities in Property-Temperature Curves for Glasses. *By W. R. Ham, A. G. Pincus, and C. H. Samans: Research Laboratory, American Optical Company, Southbridge, Mass.*

Elevated-temperature measurements of electrolytic conductivity have been made on (1) a commercial hydrated sodium silicate, (2) a 30% Na_2O-70% SiO_2 glass, and (3) a crown glass. In plots of log resistance versus $1/T$, the data fell on straight lines whose slope changed at definite temperatures. Careful analysis indicates that these transition temperatures can be classified into series, each of which is characteristic of an element present in the glass and can be expressed by equation (1).

$$T_x = ct\,(1/n_0 2 - 1/n^2) \qquad (1)$$

T_x = transition temp. in °K.
ct = series constant in °K.
n_0 = base number of series.
n = term number of series and takes successive values (n_0+1), (n_0+2), etc.

The results indicate that the base numbers of these series are determined by the electronic structure of the element of which they are characteristic. There is apparently a series occupied by the electrons in their ground states.

For oxygen, silicon, and sodium, the series constants (ct) were as follows:

	$n_0=1$	$n_0=2$	$n_0=3$
Oxygen	427	2112	
Sodium	1145	3665	7,920
Silicon	1021	2460	11,600

Data are also given for two of these glasses to which three metal ions have been added and also for sodium chloride. These furnish confirmatory evidence.

Discontinuities in thermal expansion and electrical resistance curves for glasses previously reported (1932-1934) by W. E. S. Turner and his co-workers are also discussed in the light of this viewpoint and are shown to be compatible with it.

8. Oxidation and Reduction of Colored Glasses by Means of Electrolysis. *By G. E. Rindone, Evelyn C. Marboe, and W. A. Weyl: Glass Science, Incorporated, State College, Pa.*

The existing need for controlling the state of oxidation of colored glasses led to an investigation of the possibilities of oxidizing or reducing a glass melt by means of electrolysis. A method was developed for the electrolytic oxidation and reduction of molten glass in which the anodic and cathodic reaction zones were separated by means of a refractory diaphragm.

(*Continued on page* 198)

A NEW SERIES OF SMALL RADIO TUBES

The following is an abstract of a paper by G. Alma and F. Prakke which appeared in the October 1946 issue of *Philips Technical Review*.

Reduction in the size of small radio tubes has been limited in two ways: (1) in the case of metal tubes the mutual capacities and dielectric losses between leads become too large; (2) in the case of all-glass types the cathode becomes too hot during the process of sealing the bulb to the stem. It has been found possible to produce a new series (A series or "Rimlock" tubes) with a bulb diameter of only 20.5 mm by the use of low-melting glass to seal the bulb to the stem. The diameter of the based tube is 22 mm.

The new process involves the following steps. After

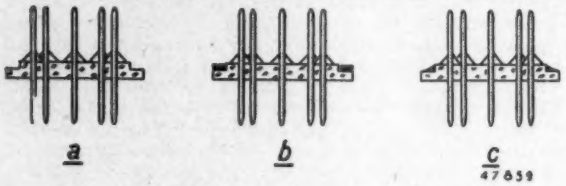


Fig. 1

the stem with its contact pins (8 in number, occasionally with 9) has been molded, a ring of molded glaze powder (powdered low-melting glass) is laid around the edge of the stem. In the annealing process the powder softens and adheres to the stem (Fig. 1). The electrodes are next mounted on the stem in the usual way. A special machine is used for sealing the mount into the bulb (Fig. 3). The stem is placed on the inverted bulb (Fig. 2), a metal cap is placed over the pins, and the assembly passes between two rows of flat flames directed radially towards the cap. In this way the edge of the bulb and the edge of the stem are heated uniformly, the glaze becomes soft, and the stem sinks far enough for the edge of the bulb to penetrate the layer of glaze. The seal, upon cooling, is vacuum-tight.

A temperature of 450 C is sufficient to make a seal. The temperature of the electrodes within the tube does not exceed 230 C, whereas if the same tube is sealed conventionally without use of the glaze the cathode temperature reaches 500-600 C.

It is essential that the glaze have a coefficient of thermal expansion practically equal to that of the bulb and stem glasses in order to prevent the development of dangerous stresses when the seal cools. The surface tension of the glaze must be maintained within proper limits.

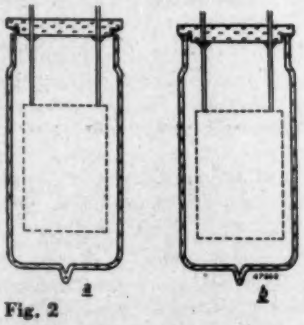


Fig. 2

In addition to the small dimensions obtained, the new method of sealing offers further advantages. An important advantage is the fact that the shape of the bulb is not distorted as in the usual method of sealing-in a stem. The bulb dimensions can be maintained to within 0.1 mm. Furthermore, the stem remains flat

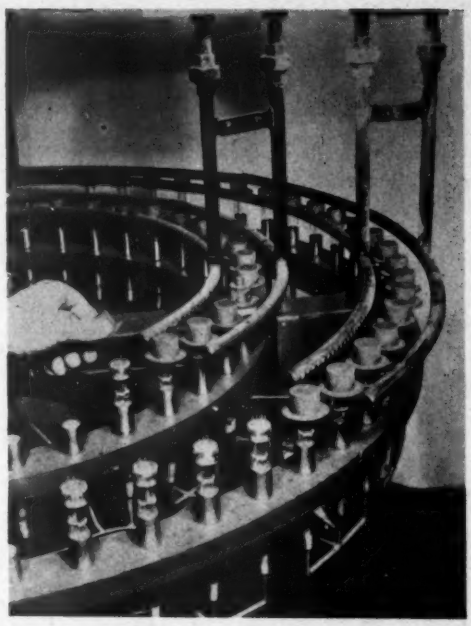


Fig. 3

and the pins accurately aligned in contrast to the conventional method of sealing where the flat stem is distorted by softening of the glass, with the result that the pins must be made of soft metal in order to withstand insertion into the socket without cracking the glass. In addition to these advantages, there is a gain in production rates because the time required for sealing-in is considerably reduced.

As far as the temperature of the cathode during the sealing process is concerned, the diameter of the tubes could be considerably smaller than 20.5 mm. The capacities and losses of the leads now set the limit. Aside from these factors, the heat developed within the tube in operation is a further limitation.

The new method is excellent for battery-operated tubes. In these it is possible to use tungsten wire for the di-

(*Continued on page* 206)

Fig. 4

ANNUAL MEETING OF THE OPTICAL SOCIETY

Glass technologists enjoyed a considerable number of contributions at the spring meeting of the Optical Society of America, which was held in New York City, February 20-22, because of their immediate service to problems in their field. This meeting, one of the best organized in the realm of scientific entertainment, traditionally includes startling reports of a nature to interest the outsider. This time the gourmet's favorite repast was the spectacular presentation of the new one-step camera of which the daily press has given an extensive account.

Glass in Optical Science

Fluorescence

Dr. W. A. Weyl, Glass Science, State College, Pennsylvania, has used his recent discoveries on the general nature of glass to propose fundamental details regarding the mechanism of fluorescence in fluorescent materials.

In his paper, "Light Absorption and Emission of Ions in Glasses and Crystals as Affected by Assymetrical Electric Fields", the physical and phenomenological form of the present concepts of fluorescence is supplemented by certain chemical principles and tangible experimental facts derived to a large extent from glass technology.

Fluorescence phenomena presuppose the energetic isolation of ions which is achieved to perfection by the molecule in its vapor state. One sided polarization of adsorbed ions on surfaces creates a very similar condition. Many sulfides, not fluorescing in the normal crystalline form, fluoresce when adsorbed at surfaces of suitable substances. One sided polarization may be imagined by visualizing the electrostatic attraction of most of the electrons of an anion to a cation placed in closer neighborhood than any other cation.

Weyl finds one-sided polarization in glasses containing small amounts of the sulfides of lead, thallium and cadmium. Such glasses fluoresce. One sided polarization, and fluorescence, can be enhanced at will, if the polarization power of chemical elements is considered on the basis of K. Fajans' theory. Many phosphors contain activators (e.g., Na) which have a much smaller polarizing effect than the "regular" cation in the lattice (e.g., Ag), so that the polarizing effect of the "regular" cation becomes one sided, e.g.:

Regular lattice ion		anion		activator
Ag^+	←	Cl^-	▌	Na^+

The concept generally explains the most favorable selections of lattices and activators for fluorescent materials. The selection is more favorable if the polarizing effect of two cations (one of them called activator) is very different; if the polarizability of the anion is greater (e.g., sulfur); if a "hole" in the structure causes one sided polarization; if anionic groups with highly charged central cations are present (e.g., vanadates); or, if two anions have widely different polarizabilities (oxygen, sulfur).

Films and Filters

The interest in evaporated films, to a large extent used in the beneficiation of glass surfaces, is growing every year. H. Levinstein and R. C. Williams, in a paper on the "Structure of Evaporated Films as Determined by Electron Diffraction and Electron Microscopy" showed and analyzed excellent electron diffraction and electron microscope pictures of metal films. All films were shown to have discontinuous structures. The discontinuities vary from 10 to 1000 Å and are shown to depend on the melting points. Metals of high melting points are giving nearly amorphous structures corresponding to smallest particle sizes. Metals of low melting points have large crystallites of preferential orientation. In an intermediate range sharp diffraction rings and visible crystallite pictures were obtained.

The audience of the remarkable presentation was appreciative. The listening chemist could not fail to think of an analogy in analytical chemistry as a memory aid for the results of these U. of Michigan physicists. The crystal size of precipitates increases with solubility. If the low melting point is thought of as high "solubility" in the vacuum the same order of appearances of films is derived.

H. S. Coleman, of Penn State, and A. F. Turner and O. A. Ullrich, of Bausch and Lomb, in a paper on "Crystal Orientation and Refractive Index of Thick Evaporated MgF_2 Films", demonstrated the startling fact that MgF_2 evaporated on glass surfaces is orientated parallel to two different crystal planes in ranges around 350°F. and around 1000°F. The change towards the orientation parallel to the 1,1,0 plane at high temperatures is accompanied by a change in refractive indices, with minimum indices at about 550°F. This theoretically interesting condition is of great practical significance, too.

C. H. Alexander, of Bausch and Lomb, described the principles and practical details of "Electron Bombardment Cleaning" of glass surfaces in preparation of evaporation of anti-reflection films or first surface mirrors.

The colored glass filters are controlled with new competitive products of great interest. The application of one or two layers of thin films has been used widely for anti-reflection films with broad spectral ranges of low reflection, or mirrors with broad spectral ranges of high reflection. Now, the simultaneous use of two semi-transparent metal films (e.g., silver) separated by a homogeneous transparent (e.g., oxide) film causes radical changes of reflection with wave length and may be organized to cause the appearance of a transmission band only 10 millimicrons wide. Combinations of more layers are also used and filters of this type for the purpose of simple monochromatizing have appeared on the market recently.

The mathematics of such film combinations on glass creating monochromatic transmission filters was discussed by P. J. Leurgans, Bausch and Lomb, in a paper on the "Exact Solution of the Interference Filter as a Boundary Valve Problem".

Although not based on glass, the passband filter should be mentioned as a more involved competitor. In these filters the polarized spectra of a number of quartz plates between parallel polarizers have been used in which suc-

(*Continued on page* 210)

ELECTRIC LAMP PRODUCTION, SHIPMENTS AND STOCKS FOR 1946-1945

The Bureau of Census has just released detailed data on the production, shipments, stocks and dollar values for 1946 on various types and sizes of electric lamps. These statistics are based on the operations of twenty-five companies, representing practically all producers of the types of lamps covered.

Shipments of electric lamps during 1946 amounted to 1,367 million lamps valued at almost $144 million, according to the report. The 1946 shipments represented an increase of 9 per cent in number and a slight decrease in value from the previous year. This is partly due to the increased shipments in 1946 of the less costly miniature and Christmas tree lamps and the small drop in the shipments of larger lamps.

The 1,338 million lamps produced in 1946 exceeded the 1945 output by 9 per cent. However, an excess of shipments over production during 1946 reduced the stocks on hand at the end of the year to 213 million lamps, 29 million less than stocks at the close of the previous year. The inventory at the end of 1946 represented about one and one-half months' shipments at the year end rate of shipments.

The number of lamps shipped during the fourth quarter of 1946 represented an increase of 42 per cent over the third quarter shipments. The value of shipments during the fourth quarter amounted to $50 million, an increase of 34 per cent over the third quarter. The fourth quarter was the peak quarter for 1946 in respect to both shipments and production.

This report contains revised data for the first three quarters of 1946 on the number of lamps produced, shipped and held in factory stocks. In this release, shipments of electric lamps represent lamps shipped from the factory or factory warehouse and do not represent the sales of lamps to ultimate consumers. Lamps shipped on a consignment basis to jobbers, dealers or distributors (including manufacturer-owned outlets) are reported at the time that they are shipped from the producing factory or factory warehouse and not at the time the sale is completed.

Data for domestic shipments represent lamps shipped to wholesalers, jobbers, retailers and direct consumers located in Continental United States and United States territories and possessions, except the Philippines. Shipments to the Philippines and to all other countries are included in shipments for export. The dollar value of shipments is based on the manufacturer's selling price, f.o.b. factory or works, exclusive of excise taxes and before cash discounts have been taken.

A total of four tables were included in the Bureau's report, the two which appear with this article and two others, one showing production shipments, stocks and dollar values for the fourth quarter of 1946 and the other showing a quarterly breakdown for 1946 in the same categories.

ELECTRIC LAMPS: PRODUCTION, SHIPMENTS, AND STOCKS, 1946 AND 1945

(Thousands of lamps)

Product	Year	Number of companies	Stocks at beginning of year	Production	Shipments	Stocks at end of year
TOTAL	1946	25	242,335	1,338,069	1,367,500	212,904
	1945	26	266,851	1,226,173	1,250,689	242,335
LARGE	1946	17	168,198	827,184	847,644	147,738
	1945	18	179,899	862,092	873,793	168,198
Incandescent, 150 watt and under	1946	17	140,134	658,566	680,349	118,351
	1945	16	143,674	709,229	712,769	140,134
Incandescent, over 150 watt	1946	15	14,376	71,027	69,397	16,006
	1945	14	18,126	77,883	81,633	14,376
Fluorescent, RF and F[1]	1946	6	8,115	52,430	53,156	7,389
	1945	5	13,879	37,017	42,781	8,115
Germicidal	1946	4	208	515	383	340
	1945	3	...	371	163	208
Photoflash	1946	3	5,365	44,646	44,359	5,652
	1945	3	4,220	37,592	36,447	5,365
MINIATURE	1946	15	70,463	334,712	352,174	53,001
	1945	14	83,800	323,988	337,325	70,463
Automotive, glass sealed beam	1946	4	1,434	15,290	15,032	1,692
	1945	3	1,437	12,360	12,363	1,434
Other automotive	1946	12	31,700	149,055	159,832	20,923
	1945	7	27,957	145,971	142,228	31,700
Miniature, other than automotive	1946	15	37,329	170,367	177,310	30,386
	1945	14	54,406	165,657	182,734	37,329
MISCELLANEOUS	1946	4	3,674	176,173	167,682	12,165
	1945	3	3,152	40,093	39,571	3,674
Christmas tree[2]	1946	3	2,090	161,152	156,138	7,104
	1945	3	380	31,360	29,650	2,090
Electrical discharge[3]	1946	4	1,584	15,021	11,544	5,061
	1945	3	2,772	8,733	9,921	1,584

[1]Does not include fluorescent Christmas tree or RP—12 "black light" but does include tubular, straight, and curved types.
[2]Includes fluorescent Christmas tree.
[3]Includes glow, sodium, RP—12 "black light" photo-chemical, mercury, and sun lamps.

ELECTRIC LAMPS: DOMESTIC AND EXPORT SHIPMENTS, 1946 AND 1945
(Quantities in thousands of lamps and values in dollars)

Product	Year	Number of Companies	Total Quantity	Total Value	Domestic Quantity	Domestic Value	Export Quantity	Export Value
TOTAL	1946	25	1,367,500	$143,865,331	1,304,545	$136,280,915	62,955	$7,584,416
	1945	26	1,250,689	144,148,250	1,189,965	136,725,192	60,724	7,423,058
LARGE	1946	17	847,644	113,524,925	808,284	107,405,626	39,360	6,119,299
	1945	18	873,793	118,143,592	835,314	111,850,214	38,479	6,293,378
Incandescent, 150 watts and under	1946	17	680,349	57,405,513	646,642	53,571,888	33,707	3,833,625
	1945	16	712,769	61,947,660	680,791	58,517,124	31,978	3,430,536
Incandescent, over 150 watt	1946	15	69,397	25,844,886	67,642	24,953,177	1,755	891,709
	1945	14	81,633	31,881,671	78,522	30,196,229	3,111	1,685,442
Fluoresent, RF and F[1]	1946	6	53,156	25,915,519	50,573	24,641,929	2,583	1,273,590
	1945	5	42,781	20,892,278	40,686	19,824,431	2,095	1,067,847
Germicidal	1946	4	383	956,085	378	941,851	5	14,234
	1945	3	163	433,816	158	430,186	5	3,630
Photoflash	1946	3	44,359	3,402,922	43,049	3,296,781	1,310	106,141
	1945	3	36,447	2,988,167	35,157	2,882,244	1,290	105,923
MINIATURE	1946	15	352,174	21,297,835	329,271	20,001,492	22,903	1,296,343
	1945	14	337,325	21,895,608	315,426	20,812,400	21,899	1,083,208
Automotive, glass sealed beam	1946	4	15,032	6,143,020	14,665	5,984,094	367	158,926
	1945	3	12,363	5,308,286	12,038	5,184,080	325	124,206
Other automotive	1946	12	159,832	8,380,171	150,062	7,751,187	9,770	628,984
	1945	7	142,228	7,641,524	135,856	7,263,903	6,372	377,621
Miniature other than automotive	1946	15	177,310	6,774,644	164,544	6,266,211	12,766	508,433
	1945	14	182,734	8,945,798	167,532	8,364,417	15,202	581,381
MISCELLANEOUS	1946	4	167,682	9,042,571	166,990	8,873,797	692	168,774
	1945	3	39,571	4,109,050	39,225	4,062,578	346	46,472
Christmas tree[2]	1946	3	156,138	5,027,202	155,547	4,947,422	591	79,780
	1945	3	29,650	955,840	29,442	949,840	208	6,000
Electrical discharge[3]	1946	4	11,544	4,015,369	11,443	3,926,375	101	88,994
	1945	3	9,921	3,153,210	9,783	3,112,738	138	40,472

[1]Does not include fluorescent Christmas tree or RP—12 "black light" but does include tubular, straight, and curved types.
[2]Includes fluorescent Christmas tree.
[3]Includes glow, sodium, RP—12 "black light," photo-chemical, mercury, and sun lamps.

STATUS OF BRITISH GLASS INDUSTRY

Major problems facing the British glass industry are shortages of raw material, coal and labor. A drastic shortage of soda ash, originating in a shortage of coal, has been to date perhaps the most serious problem, while the loss of Continental imports estimated at six hundred thousand pounds a year prewar has thrown an added burden on the British manufacturer.

Effort is now directed towards converting this six hundred thousand pound per annum debit import cost into a 2½ million pound export credit balance and the increase in export over the war years from 11 million gross in 1934 to between 16½ million and 17 million gross in 1946 suggests that this can be achieved.

The crux of the matter is undoubtedly the fuel position. Discussing the flat glass industry, the "Financial Times" states—"A single private company, Pilkington Bros., of St. Helens, predominates in flat glass manufacture of which there are two main types, plate glass and sheet glass. Both of these are melted and refined in the same kind of tank furnace, but plate glass passes through special rollers and is then ground and polished on both surfaces simultaneously by elaborate machinery so that it becomes clear with surfaces flat and parallel.

"The war greatly increased the demands on the flat glass industry and much special production was undertaken. But now the switch-over to normal production is complete and plans made as far back as 1941 to increase plant in order to meet the present demand are already partly in operation but will not be complete until 1949. Already far more plate and sheet glass is being turned out than before the war. Production of plate glass is double that of twelve months ago, but exceptionally heavy demands, not only for bomb damage replacements but for the motor trade and utility furniture manufacture—a surprisingly large amount is used for mirrors in utility bedroom suites—restrict its general availability.

"The biggest demand of all, of course, is for sheet glass for housing, although here there is not so much congestion of orders for the simple reason that most of the uses are subject to licensing. And although production is still below demand, sheet glass is not officially regarded as one of the critical materials. Already one new sheet glass manufacturing unit is in production which will produce a million square feet a week; a further one will be in production at Pontypool within the next few months and when this is working the country's output will be nearly three times as much as it was ten years ago. This supply picture must be seen against a background of world-wide shortage and in relation to the pre-war export-import position.

"Before the war, large quantities of flat glass were imported here from the Continent, and although there was a world-wide British export trade, imports exceeded exports by about £600,000 a year. In 1946 flat glass exports were not very far off double the 1938 volume. Broadly speaking, only plate glass is being exported and only sheet glass is being imported. Licenses for the import of Belgian sheet glass are being freely granted, but the quantities available are only a fraction of prewar. In December total imports in the category of plate and sheet glass came to 17,684 tons against a monthly average in 1938 of 127,710 cwts. But as the first shipment of Belgian glass arrived only in August, this year's supplies from abroad should be more helpful in easing the sheet glass position."

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Turning-out Device for Press Molds. Fig. 1. Patent No. 2,416,743 is an invention of Albert H. Forgar of Los Angeles, California, and it relates to a mechanism for turning-out or removing the ware from a press mold. On heavy ware, this has been a job requiring hard manual labor but this invention makes it comparatively easy.

The upper part of Fig. 1 shows the plunger 12 and mold 13 in pressing position. The mold is positioned on the bed plate 10 by stops 14 when in pressing position. Projecting from the mold 13 is a rod 15 which passes through an opening 16 in a bracket 17 fixed on the bed plate. The rod carries a disc 18 of such diameter that it just clears the bed plate 10 when the mold is in pressing position. The rod may be straight or bent slightly as shown at 15a. The rear end of the rod carries a stop collar 19 which is adapted to engage the bracket 17 at times.

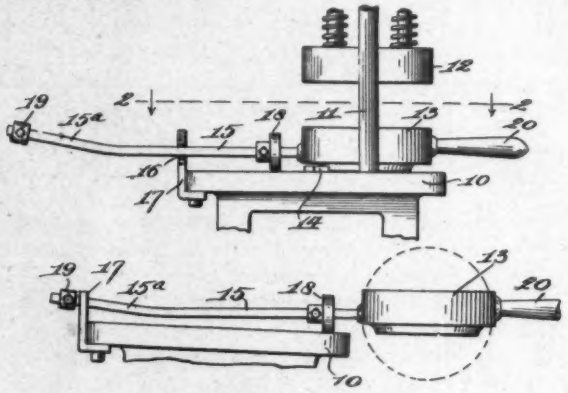


Fig. 1. Turning-out Device for Press Molds.

In the use of this device, a charge of molten glass is placed in the mold while it is drawn forward as shown in the lower part of the figure. The stop collar 19 limits the outward movement of the mold and at this time it is supported by the disc 18. The mold is then moved back by the handle 20 into pressing position on the bed plate as shown in the upper part of the drawing. After the ware is pressed, the mold is drawn forward clear of the plate 10 where it may be easily turned over, rolling on the disc 18 to discharge the finished ware.

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	*Name*	*Date*
91,119	Haines	June 8, 1869
212,850	Hemingray	Mar. 4, 1879
519,113	Grebe	May 1, 1894
696,254	Nash	Mar. 25, 1902
164,517	Brooke	June 15, 1875

Method of Making Footed Stem Ware. Fig. 2. Patent No. 2,417,328 is on a method of making footed ware such as goblets, wine glasses, etc. It is an invention of Theodore H. Sloan of Charleroi, Pa., and assigned to G.M.S. Corporation of Pittsburgh.

The patent states that no satisfactory method has heretofore been known for making footed ware by pressing in one piece except by the use of several hand operations. Such methods as have been proposed result in seams on the foot which are objectionable.

According to this invention, a series of molds 10 are mounted on the table 11 of a press. In Fig. 2, a charge of molten glass has been deposited in a part of the mold 15 and a blow-head forces some of the glass downwardly to form a stem 25 which is shaped by a plunger coming up from below. A second plunger 26 then presses the foot 27. The upper part of the ware is formed by a plunger 28, collar 29 and ring 14. After this, the lower mold parts are cracked to allow the glass to cool and the mold advances to the take-out station.

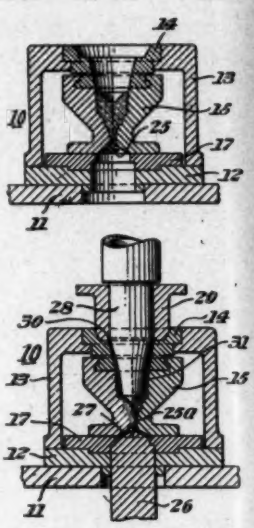


Fig. 2. Method of Making Footed Stem Ware.

This method of forming the foot has the advantage of having the exact amount of glass in position for the pressing operation. Ware made by this method is free from seams which have formerly been present.

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	*Name*	*Date*
2,070,493	Rosa	Feb. 9, 1937
Re. 5,924	Reighard	June 16, 1874
567,236	Hilde	Sept. 8, 1896
2,276,399	Hrdina	Mar. 17, 1942

FOREIGN PATENTS

Number	*Country*	*Date*
488,603	British	July 11, 1938

Glass Compositions

Corning Infrared Transmitting Glass. Fig. 3. Patent No. 2,416,392 is on a glass which is opaque to visible radiations but transparent to infrared radiations. It was invented by Harrison P. Hood who assigned it to Corning Glass Works. This glass is suitable for use in photoelectric cells and in infrared therapy.

Heretofore, glasses of this character were colored with manganese, as shown for example in Patent No. 1,411,-133 to Taylor. This inventor has discovered that an improved glass of this general character may be made by coloring a silicate glass with selenium, cadmium sulfide and cobalt oxide. Any silicate glass containing at least 2

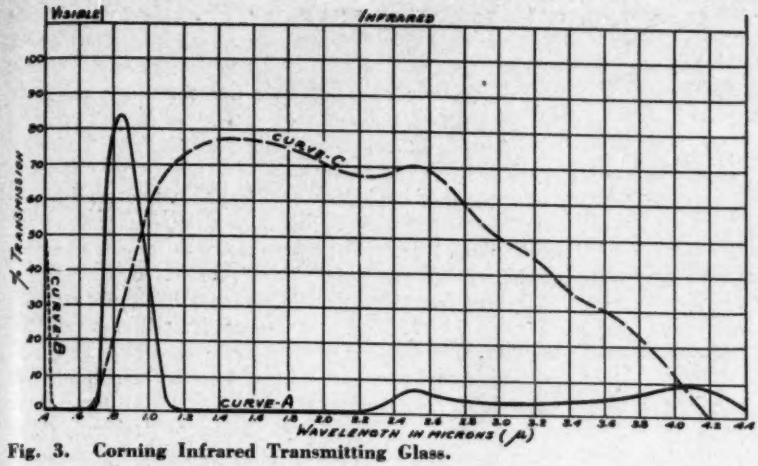


Fig. 3. Corning Infrared Transmitting Glass.

per cent of zinc oxide will develop a ruby color with selenium and cadmium sulfide and this is desirable.

The following table gives five examples of the compositions according to this patent figured in weight percentages as calculated from the batches:

	1	*2*	*3*	*4*	*5*
SiO_2	58.0	67.3	69.7	58.0	54.2
K_2O	17.3	...	...	8.4	8.4
Na_2O	...	16.8	18	8.4	8.4
ZnO	7.2	9.3	4	9.3	9.3
BaO	13.2	...	...	...	...
CaO	...	...	4	...	...
B_2O_3	...	...	...	9.3	9.3
Al_2O_3	...	...	...	...	3.8
Se	.7	1.9	.7	1.9	1.9
CdS	1.0	1.9	1.0	1.9	1.9
CoO	2.6	2.8	2.6	2.8	2.8

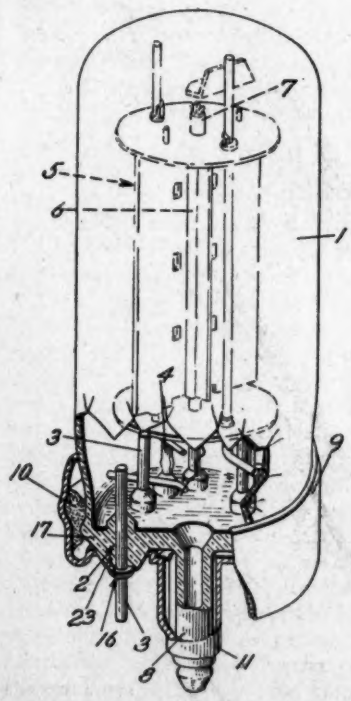


Fig. 4. Stem for Electrical Tubes.

In Fig. 3, the curve A shows the transmission of glass 3mm. thick made in accordance with No. 1 of the preceding table when made with Co_2O_3 and subsequently "warmed in". The curve B shows the small visible transmission of this glass before "warming in". The curve C shows the transmission of glass 2.5mm. thick as made in accordance with the Taylor Patent No. 1,411,133. The advantage of this glass composition will be apparent from a comparison of the curves.

The following references are of record in the file of this patent: United States Patents: 1,864,858, Rising, June 28, 1932; 1,924,752, Rising, Aug. 29, 1933.

Stem for Electrical Tubes. Fig. 4. Reissue Patent No. 22,851 relates to an improved stem for electrical space discharge devices. The original patent was issued to Percy L. Spencer on Aug. 4, 1942 as Patent No. 2,291,660 and assigned to Raytheon Manufacturing Company. The patent provides a strong seal for the lead-in conductors.

As shown in Fig. 4, the tube comprises a glass envelope 1 having a stem or base 2 into which the lead-in conductors 3 are sealed. Dummy support wires 4 may also be sealed to the upper surface of the stem. The usual type of mount is indicated at 5, 6 and 7. An exhaust tube 8 projects from the bottom of the stem and is protected by a guard 9 and 11.

Each conductor 3 is provided with an annular disc 17 which is sealed to the stem, preferably in the manner shown in Patents No. 2,310,237 and 2,321,600 issued to Clarence A. Horn. This results in a tube of unusual strength in the contact pins and one not easily broken.

The following references are of record in the file of this patent: United States patents 1,935,942, Conner, Nov. 21, 1933; 2,106,578, Schwartzwalder et al, Jan. 25, 1938; 2,089,044, Thomas, Aug. 3, 1937; 1,067,024, Hall et al, July 8, 1913.

Miscellaneous Processes

Hartford Finish Gauge. Fig. 5. Patent No. 2,415,693 is on a gauge for determining the accuracy of the outside finish of jars, etc., where it is to be engaged by a closure. This invention was assigned to Hartford-Empire Company by Henry W. Ingle.

It is well known that a cap cannot make a good seal on a seat which is too large or too small or which is too much out of round. A rough test may be made with outside calipers or with micrometers but such tests are slow to make and not reliable. This invention provides a hand tool which may be placed over the top of a jar when one or the other is rotated, any variation from the desired diameter of the sealing surface will be shown on an indicator.

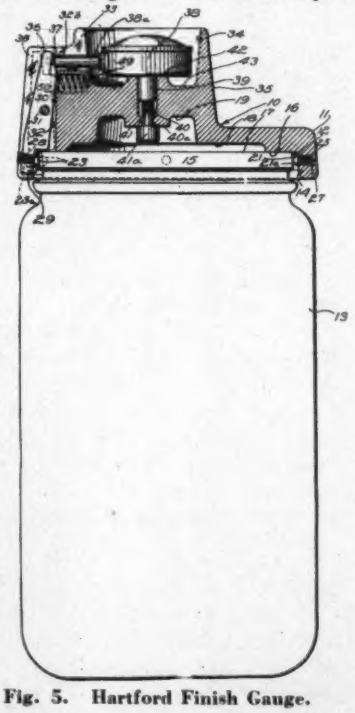


Fig. 5. Hartford Finish Gauge.

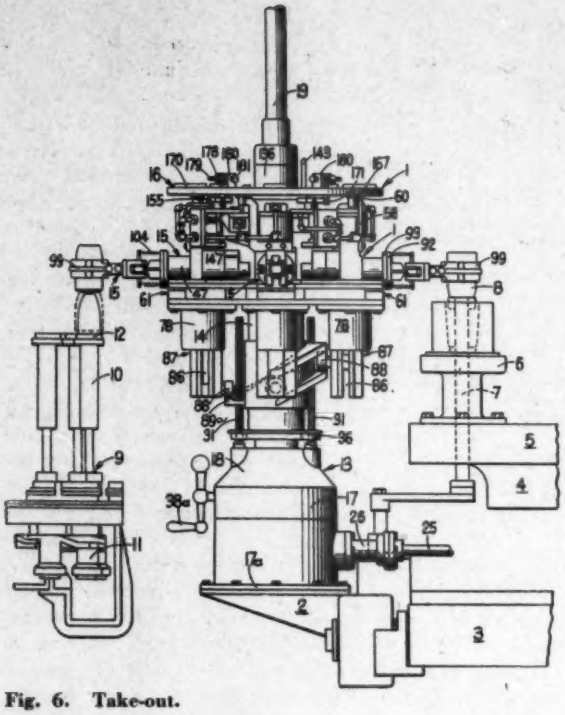


Fig. 6. Take-out.

Fig. 5 shows a section of this new gauge in working position on a glass jar. The body 10 of the gauge has a lower chamber 12 slightly larger than the finish of the jar to be tested. The top surface of the jar 13 engages an annular bearing 16 which determines the distance down from the top to the point of measurement. Projecting radially into the chamber 12 are three fixed buttons, one of which is shown at 21, these being spaced 90 degrees apart. These provide three contact members which center the jar in the gauge. A fourth contact member 23 is fixed in the lower end of a lever 30 pivoted in the gauge at 31 and the contact is held against the sealing surface of the jar by a spring 49. The upper end of the lever 30 engages a stem 37 projecting from a dial indicator 38. An indicator suitable for this purpose is made by the Federal Products Company of Providence, R. I., and is known as the "Federal Dial Indicator, Model A-6Q". As is usual, the dial reads in thousandths of an inch, plus and minus, the standard dimension.

The contact buttons are adjustable and they may be set by the use of a master gauge. The use of this device will be apparent to anyone familiar with measuring glassware. If the finish is shown to be dangerously out of round, the ware can be discarded at once and corrections made on the forming machine. The construction of the body 10 protects the device from accidental injury which is the principle feature of the invention.

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	*Name*	*Date*
2,338,868	Owens	Jan. 11, 1944
2,327,629	Fedorchak	Aug. 24, 1943
1,206,202	Bright	Nov. 28, 1916
1,446,149	Benoit et al	Feb. 20, 1923
1,658,994	Lauer	Feb. 14, 1928

Take-out. Fig. 6. Patent No. 2,415,997 is a take-out for removing ware from a forming machine and placing it on a conveyor. It is an invention of John W. Eldred of Columbus, Ohio. This machine removes ware from an intermittent machine and places it on a conveyor, with or without invertion. The machine is of the turret type having a series of tongs which pick up the ware from one level and deliver it to another level if necessary, invert the ware if this be desired, and which runs continuously although operating with an intermittent forming machine.

The machine is shown in Fig. 6 as having four pairs of tongs 99 which pick up a tumbler 8 at the right of the figure, invert it and deposit it on a cup 12 which may be a part of a glazer 9. A base 13 carries a turret 14 which provides mechanism by which the tongs have a dwell at the take-out and discharge positions. The forming machine 4 has a table 5 carrying molds 6. The usual valve 7 is provided for lifting the ware from the mold. The machine is driven by a shaft 25. The working level of the table is adjusted by a handle 38a which operates screws 31. The turret 14 carries the article handling units 15 in such a way that they may swing horizontally and move radially. A cam 61 imparts a radial movement to the tongs. When it is desired to invert the ware, this is accomplished by the roll 89 and its cam which may or may not be used.

The tongs are operated by air and various forms of tongs are provided. A cam mechanism causes the tongs to remain stationary during the pick-up and again when the ware is set down.

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	*Name*	*Date*
940,165	Koenig	Nov. 16, 1909
1,461,222	Myers	July 10, 1923
1,654,091	Peiler	Dec. 27, 1927
2,359,432	McNamara	Oct. 3, 1944

Owens Burn-off Machine. Fig. 7. Patent No. 2,416,121 is on a machine for burning off the moile from glassware made on a blow pipe or spindle. This is an invention by Carl W. Schreiber and Karl B. Vollstorf who assigned it to Owens-Illinois Glass Company. The patent shows a machine for burning off moiles from tumblers and forming a bead on the top edge of the finished ware.

Fig. 7 shows a vertical section through a turret type machine having 24 heads. The machine has a base 30 mounted on wheels 31 and having a central column 32. The column is surrounded by a spider 30^a mounted on the base and carries an upper spider 30^b. A carriage C rotatable about the central column carries the burn-off units each of which includes a ring burner 34, a bottom plate 35 which supports the tumbler 36 and a gripping device 37. Jaws 195 are provided to grip the moile 38 while the tumbler is held on the bottom plate by suction.

In the operation of the machine, the bottom plate starts rotating as soon as the tumbler is placed on it, where it is held by suction. The bottom plate then rises and a heating flame is directed against it by a burner 115. At the same time, the jaws 195 grip the moile and a flame from the ring burner 34 is directed against the tumbler to start burning off the moile. The jaws lift

(*Continued on page* 204)

Research Digest

Selenium-Ruby and Other Glasses Colored by Selenium

In this work, which is reported by Pavlish and Austin in the January, 1947, issue of *The Journal of the American Ceramic Society*, particular emphasis was placed on the determination of the factors necessary for the production of selenium-ruby tableware on a volume basis in continuous tanks. All work was therefore done on a zinc-free base glass composition suitable for use in machine production. Some work was also done on the development of colors other than ruby by employing selenium. Pink glasses and the decolorization of glass by selenium were not considered in this investigation.

Previous work had pointed out the possibilities of using reducing agents in the batch to effect controlled reducing conditions within the melt to retain selenium and cadmium in the requisite amounts. This line of attack was followed further in the present work. To a base glass of the following composition, Silica 72.8, Alumina 2.5, Calcia 6.4, Magnesia 4.2, Sodium oxide 12.6 and Potassium oxide 1.5, there were added various amounts of selenium, silicon, cadmium (either as sulphide, phosphate or metallic). In addition, sodium nitrate was also added to a few of the glasses. The melts were made in both commercial and laboratory day tanks using natural gas and a "soft flame". Melting and fining was accomplished in 13 to 18 hours at a temperature of 2700°F. The glass was then gathered, pressed in hand presses and, in the case of tests made at a commercial plant, run through a commercial glazer.

These large-scale trials confirmed the laboratory results as regards selenium content. Approximately 0.05 per cent Se is necessary to develop the ruby color under the conditions employed. Approximately the same amount of Cd gave satisfactory results; a lesser amount of S of the order of 0.01 per cent was sufficient. The amount of Se retained in the glass was controlled effectively by the use of silicon. The silicon required is apparently decreased by the use of metallic cadmium in place of cadmium sulphide.

The color development, as well as the color obtained, was a function of the selenium content of the glass. In the case of the glass containing 0.05 Cd, 0.013 S and 0.046 Se gathering at 2100°F. gave a ruby as pressed except for the outer rim. Commercial glazing treatment produced a "rich" uniform ruby color throughout the specimen.

Selenium retention can be increased markedly by the use of reducing agents in the batch. The amount retained was depended on: 1) Amount of Se added, 2) specific reducing agent added, 3) amount of specific reducing agent added and 4) manner of adding cadmium. On the basis of effectiveness, price and desirable end products, silicon appears to be the most desirable reducing agent to use in selenium ruby glass batches. Fig. I shows the effect of silicon on selenium retention.

Various oxidizing agents alone or along with reducing agents were tried to increase the retention of both Se and Cd. The results showed that conditions most favorable for the retention of Se affected adversely the retention of Cd. The most economical production of selenium-ruby glass is a question of balancing the reducing agent used and the amount to effect the maximum retention of both Cd and Se.

Little is known regarding the use of selenium in glasses other than pink or ruby and as it is known that Se combines with various metals to form colored selenides, some preliminary work has been done in this field.

To a base soda-lime-silica glass, various metallic cations, added as the oxide in most cases, were added in amounts of 0.1 per cent. Se in amounts of 0.1 to 0.32 per cent and silicon in the amount of about 0.03 to 0.70 per cent were also added. Laboratory melts at 2700°F. were made.

The following metallic cations, when used in conjunction with Se, produced glasses which were black, brown or amber in color: lead, tin, manganese, cerium, zinc, titanium, nickel, silver, iron and copper. Interesting colors of light shades were obtained with the following: bismuth, iron and arsenic.

Jet black glasses (reflected or transmitted light) were obtained with 0.1 per cent copper oxide, 0.25 per cent selenium and 0.15 per cent silicon. A fiery, amber colored glass was obtained by the addition of 0.1 per cent iron, added as ferrous

(*Continued on page* 190)

MELT NUMBER	CADMIUM IN GLASS, %	COLORANT RECOVERY, %		COLOR OF GLASS		
		CADMIUM	SELENIUM	SLOW-COOLED	QUENCHED	REHEATED
29	0.04	14	11	RUBY	AMBER	RED-BROWN
41	–	–	11	RUBY	AMBER	RUBY
92	–	–	11	BROWN-RUBY	AMBER	BROWN-RUBY
112	–	–	8	OPAQUE RUBY	AMBER	RUBY
81	–	–	10	DARK BROWN	RUBY	BROWN-RUBY
126	–	–	16	OPAQUE	BROWN	–
127	–	–	21	OPAQUE DARK BROWN	BROWN	–
82	0.02	7	47	BROWN BLACK	BROWN	BROWN
231	–	–	8	RUBY	YELLOW	RUBY
221	–	–	16	BLACK	RUBY	OPAQUE BROWN
229	–	–	11	RUBY	YELLOW	BROWN-RUBY
230	–	–	25	BLACK	BROWN-RUBY	DARK RUBY

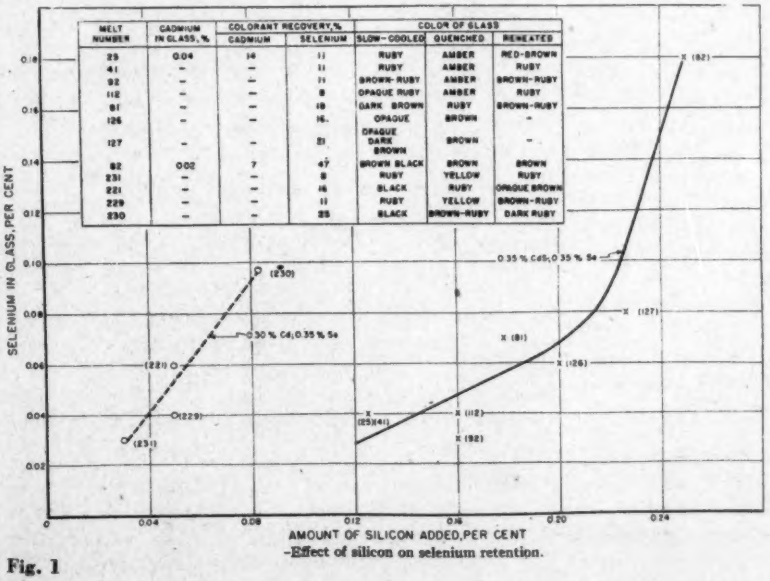


Fig. 1 –Effect of silicon on selenium retention.

F.T.C. REVERSED ON DEFINITION OF GLASS

According to a recent court decision, articles which resemble glass may be advertised and sold as "glass", regardless of their composition or properties.

It was so held by the United States Circuit Court of Appeals in Chicago, in reversing the Federal Trade Commission in a case involving men's accessories made of "Vinylite" resins, which were sold under the trade name "Elasti-Glass" and represented in advertising as "organic glass".

The Federal Trade Commission had previously determined that such trade name and representations constituted unfair trade practice, and had issued a cease and desist order accordingly. The Commission concluded that glass, as understood and recognized by the general public, is a hard, transparent, brittle material, such as the common glass found in window panes, tumblers and bottles, with a relatively high softening point, substantially insoluble in water and organic solvents, and noninflammable in the usual sense. It held that "Elasti-Glass" products were not glass as generally understood, and that the use of such trade name had the capacity and tendency to mislead and deceive a substantial portion of the purchasing public into the erroneous and mistaken belief that the products so designated were made from common glass specially processed in some manner to make them pliable and elastic.

In vacating and setting aside the Commission's order, the Court did not consider the meaning of the term glass from a technical or scientific standpoint, but referred only to lay dictionary definitions. Its opinion reads, in part, "Of course, neither the Oxford nor any of the many American dictionaries which we have consulted limit the definitions of the word 'glass' to that made from silica, or to that from which window panes or goblets are usually made. True, the latter are perhaps the most usual forms in which we see glass, but each dictionary defines the word as a substance that resembles glass. The word is not derived from any element or combination of elements from which any kind of glass is made. From all sources available to us it is clear that the word 'glass' derives from the appearance of the product after it is made."

As a matter of legal definition for trade purposes, therefore, glass is any substance that resembles glass in appearance. Literally interpreted, this definition covers a multitude of different materials and products, depending upon what one understands to be the appearance of glass. Its color, as well as its properties, may be controlled and varied by the addition of different compounds to the batch and manufacturing technique. In a cathedral window, its appearance is not the same as in a frosted window; in fiber form its appearance is not the same as in a tumbler.

The Court does not require that marketers of products resembling glass, in representing them as glass, must explain the sense in which they use the term "glass". Is it, then, to be incumbent upon the marketers of articles made of glass—the traditional inorganic glass—to assume the burden of explaining the terminology they have long employed?

The problems of such character arising from this decision require the serious consideration of members of not only the glass industry but of the plastics and other industries as well.

BOOK REVIEW

Examination of Industrial Measurements

By John W. Dudley, Jr.

It has been said that industry needs not so much professional statisticians as a generation of statistically minded engineers and chemists. If this little book by Dudley serves that purpose, it will justify its publication. As an introduction to the statistical treatment of industrial data to an engineer not previously exposed to the methods, it may serve to increase his sympathy and whet his appetite for more. But too much territory is covered in too few pages to permit the reader to apply the techniques without further study.

The book will be most useful, perhaps, to those who encounter statistical discussions in reports within their own organization and in current journal articles, and who need a little insight into how the results are obtained.

The selection of topics is unusually complete, and besides the essential discussions of frequency curves and quality control charts, chapters are devoted to significant differences, correlation and curve fitting and to subjects not often presented such as limits based on medians and the examination of runs. The treatment, however, is overly simplified and the reader who wishes to "examine industrial measurements" would do well to fortify himself with some of the standard textbooks which the author lists on page 110.

Published by McGraw-Hill Book Company, 1946. 113 pp., 8 x 5 in.; cloth, $2.00.

Robert F. Ferguson

GMCI ANNOUNCES ANNUAL MEETING

The annual meeting of the Glass Container Manufacturers Institute has been scheduled for April 30, May 1 and 2, 1947, at Grove Park Inn, Asheville, North Carolina.

Tentative plans call for the following program: Meetings on April 30 and May 1 will be under the auspices of the Board of Trustees for the purpose of receiving semi-annual reports from the nine standing committees and making the same available to the industry generally.

The annual Membership Meeting is to be held May 2. This meeting will be open only to glass container and closure manufacturers and allied and supplier companies that are regular members of the institute. Included in the business to be transacted is the election of four Trustees to serve a three-year term.

FIBERGLAS INSULATION PRODUCTION BEGINS

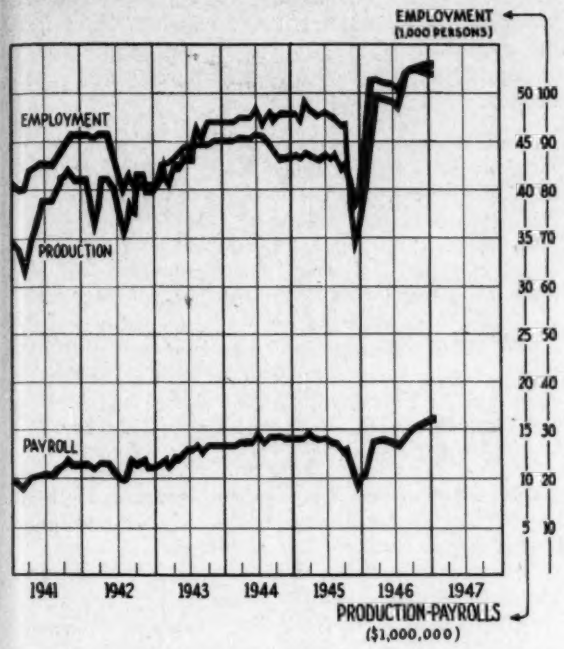
It has recently been announced that production of Fiberglas building insulation has begun in the new Owens-Corning Fiberglas Corporation plant at Kansas City, Kansas.

Production of Fiberglas building insulation in the Kansas plant is designed to serve markets in the middle, south and far west and will make available the production of the Newark plant (formerly producing most of the insulation material) for increased shipments to the eastern market when additional freight cars are available to serve that area.

• Announcement has been made of the purchase of the Old Jersey Glass Company, Inc., and The Dell Company by Vogue Ceramics Industries, Inc. The two companies will be known as Old Jersey Glass Company.

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



According to the Production Index, activity in the glass industry dropped only slightly and remained the approximated $57,000,000 for January 1947 as it was for December 1946. Production for January 1946, however, was about 46 per cent under January this year, or $39,000,000.

Employment and payrolls: The only variation in the employment figure for January 1947 is that it rose from slightly under 104,000 persons employed during December 1946 to slightly over the same figure for January. Employment in the glass industry during January 1946 was 87,300 persons which is about 19 per cent below January this year.

Payrolls also remained much the same for the month of January 1947 and were an approximate $16,000,000 as in December 1946. Payrolls reported for January 1946 were $10,600,000—close to 50 per cent under January this year.

Glass container production, based on figures released by the Bureau of Census, fell off about 20 per cent for the month of February 1947 after setting an all-time high of 11,154,977 gross in January 1947. The February production figure is 9,269,161 gross. February 1946 production of glass containers was 8,986,852 gross—or about 3 per cent under February this year. The production total for the first two months of 1947 is 20,424,138 gross which is about 8 per cent over the 18,831,119 gross produced during the corresponding months of 1946.

Shipments for February 1947 also dropped and were reported to be 8,859,933 gross. This is about 16 per cent under the 10,650,866 gross shipped during January 1947. During February 1946, shipments were 9,032,312 gross, or about 1 per cent more than for February this year. Total shipments made thus far in 1947 are 19,510,799 gross.

Inventories on glass containers at the close of February 1947 were 4,544,565 gross in comparison with 4,167,273 gross and 4,293,485 gross at the close of January 1947 and February 1946, respectively.

Plate glass production for the month of February 1947, according to the Hughes Statistical Bureau, dropped about 7 per cent to 20,267,537 sq. ft. The

(*Continued on page* 190)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production February 1947	*Stocks February 1947*
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries & Cosmetics	Narrow Neck....	3,013,043	1,954,486
	Wide Mouth..	2,864,820	1,020,109
Dairy Products		329,391	187,622
Home Canning		*120,797	557,120
Beverages, Returnable		643,008	401,625
Beverages, Non-returnable		.....	.....
Beer, Returnable		821,293	77,328
Beer, Non-returnable		38,232	8,145
Liquors		1,086,146	200,562
Wines		247,230	95,796
Packers' Tumblers		105,201	41,772
Total		9,269,161	4,544,565

*This figure represents Fruit Jars only.

GLASS CONTAINER SHIPMENTS

(All figures in gross)

	February 1947
Narrow Neck Containers	
Foods	681,987
Medicinal & Health Supplies	1,049,208
Chemical, Household, Industrials	488,835
Beverages, Returnable	568,612
Beverages, Non-returnable	.....
Beer, Returnable	769,866
Beer, Non-returnable	33,798
Liquors	1,033,468
Wines	228,621
Toiletries & Cosmetics	515,669
Sub-Total (Narrow)	5,370,064
Wide Mouth Containers	
Foods	2,354,592
Dairy Products	286,177
Home Canning	*37,635
Medicinal & Health Supplies	249,079
Chemical, Household, Industrials	132,490
Toiletries & Cosmetics	121,470
Packers' Tumblers	93,891
Sub-Total (Wide)	3,275,334
Total Domestic	8,645,398
Export Shipments	214,535
Total Shipments	8,859,933

*This figure represents Fruit Jars only.

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CURRENT STATISTICAL POSITION OF GLASS . . .

(*Continued from page* 189)

figure reported for January was 21,979,614 sq. ft. During February 1946, plate glass production was 13,849,437 sq. ft. which is about 46 per cent under February this year. Total production thus far in 1947 has reached the figure of 42,247,151 sq. ft. as compared with 18,204,728 sq. ft. produced during the first two months of 1946.

Automatic tumbler production for the month of February 1947 fell off about 32 per cent to a figure of 5,064,585 dozens. The previous month's production was 7,585,781 dozens and the figure reported for February 1946 was 6,465,397 dozens. During February 1947, shipments were 4,875,142 which also represents an approximate 32 per cent drop from the January 1947 figure of 6,352,415 dozens. Shipments during February 1946 were 6,137,939 dozens. Stocks on hand at the close of February were about 3 per cent more than for the previous month: February, 5,284,665 dozens and January, 5,095,222 dozens. Stocks at the close of February 1946 were 4,879,432 dozens.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for the month of February 1947 dropped a little over 40 per cent to a total of 2,667,998 dozens. The January figure was 4,489,302 dozens. During February 1946, sales were 3,681,302. Total sales for the March 1946-February 1947 twelve-month period were 45,208,488 dozens.

Because of lateness, one company's figures are not included in the figures for automatic tumbler production and table, kitchen and household glassware. The totals for this company, however, have been estimated for the compilation of the above figures.

RESEARCH DIGEST . . .

(*Continued from page* 187)

oxalate, and 0.25 per cent selenium as the colorants and the employment of 0.10 per cent silicon for selenium retention. A very attractive topaz was developed by the addition of 0.10 per cent bismuth trioxide, 0.10 per cent selenium and 0.035 per cent silicon.

DEDICATION OF A.S.T.M HEADQUARTERS BUILDING

The Headquarters Building of the American Society for Testing Materials located on Philadelphia's Parkway was formally dedicated at exercises held recently.

Dr. G. H. Clamer, senior living Past President, presented the building on behalf of the membership to A.S.T.M. President, Arthur W. Carpenter. Representatives were present from other national societies, organizations in the Philadelphia area, the City of Philadelphia and industry.

The purchase and enlargement of the building was made possible through gifts from the A.S.T.M. members. The building is a four-story structure and improved working facilities are provided for the Society's staff.

NEW EQUIPMENT AND SUPPLIES

GLASS MOLD HANDLES

The Anchor Manufacturing Company, Piqua, Ohio, has announced immediate delivery on glass mold handles in straight, shaped and tapered pat-

terns in lengths varying from 4″ to 10″.

Manufactured especially for the glass industry, these handles are carefully turned and have a smooth finish. All handles are fitted with the standard malleable iron ferrule and straight styles and tapered styles are available in lengths from 4″ to 10″ with the shaped handle available in lengths from 7″ to 10″.

The handles are manufactured from a selected hardwood. Samples and prices may be obtained upon request.

BABCOCK & WILCOX DEVELOPS HEAT RESISTANT CONCRETE

The Babcock & Wilcox Company, Refractories Division, 85 Liberty Street, New York 6, New York, has developed a concrete which will withstand temperatures as high as 3000° F., according to a recent announcement.

Known as "B & W Kaocast", the product fills a need for a refractory castable in the construction of industrial furnaces operating at temperatures ranging from the top limit of standard refractory castables up to as high as 3000° F.

Because it can be either poured into place like ordinary concrete used in construction work, or used as a ramming mixture, B & W Kaocast will effect considerable savings in furnace construction, it is stated. This is particularly true of furnaces requiring extensive use of special shapes which were formerly made of kiln-fired materials or of refractory plastics. Kaocast can be used either for the quick fabrication of these special shapes or to form part or all of the furnace lining.

Other applications listed by the company where Kaocast will cut down construction time and reduce furnace maintenance, include its use as a covering for studs in water-cooled furnace walls and in forming high temperature baffles. Its ability to resist spalling also makes it suitable for use on furnace car tops which are subjected to repeated heating and cooling cycles.

NEW FURNACE OBSERVATION PORT

The A. P. Green Fire Brick Company, Mexico, Missouri, has introduced a newly designed, air-cooled observation port for use in all types of industrial furnaces. Weighing only fourteen pounds, it can be easily installed in any new or old furnace wall; common brick, firebrick or steel cased.

The wide angle vision of the Perfecto Observation Port permits the operator to observe furnace and grate conditions with no disturbance of the firing cycle and without exposure to heat or glare. Simplicity of design, with self closing air-cooled ribbed shutter and divided blue pyrex window, prevents malfunction from furnace heat.

AIR SETTING REFRACTORY CEMENT

Armstrong Cork Company, Lancaster, Pa., has introduced a new air setting refractory cement, called Armstrong's Air Set, which is designed for use as a bonding mortar with fire brick and insulating fire brick.

It is also recommended as a protective facing for fire brick or insulating fire brick furnace linings. Air Set is said to reduce maintenance costs because it provides a tight, permanent joint and strong bond that does not allow brick to become loose in the wall and protects the furnace lining.

Laboratory tests have shown that Air Set has a cold bonding strength of over three times the 200-pound per square inch required by highly exacting specifications set up by the American Society for Testing Materials. This factor assures a strong bond in the cooler portions of the wall, as well as in the brick work which is exposed to high temperatures.

MINNEAPOLIS-HONEYWELL DEVELOPS NEW MERCURY SWITCH

The Minneapolis-Honeywell Regulator Company, Minneapolis, Minnesota, has developed a new mercury switch which is said to be capable of handling almost any switching job.

Less than an inch and a half long, the new switch is rated at one ampere for 115 volts, A.C. Simple in design, economical in cost, it will save space in switch action mechanisms. The new device is actuated by a snap tilt of 12 degrees using a sling pole, single throw action.

ELECTRONIC PYROMETRIC CONTROLLER

Taco West Corporation, 2620 South Park Avenue, Chicago, Illinois, has announced the new Veritron electronic pyrometric controller offering features including a new electronic circuit, ultra compact design and simplified operation. It is specially suited for direct installation on industrial furnaces and plastic molding machines.

The electronic control mechanism is absolutely stable, it is stated, and is unaffected by line voltage variation, surge effects, tube ageing or component changes. A pointer movement upon scale of .002″ produces exacting relay operation.

Measuring system and electronic mechanism are separately housed in sealed units that plug in to the instrument case. The complete instrument measures only 7⅛″ x 5¾″ x 5¼″ and may be either flush or surface mounted. A full five-inch mirrored combination scale is standard.

CATALOGUES RECEIVED

The Bailey Meter Company, 1050 Ivanhoe Road, Cleveland 10, Ohio, has issued Bulletin 105-B listing a number of advantages of the three-element system. The bulletin, "Bailey Three-Element Feed Water Control," shows chart records illustrating operation under difficult conditions and gives a large list of users.

Chart records of dump load tests conducted on a 400,000 lb. per hour capacity, pulverized coal-fired boiler are shown. Other chart records illustrate the operation of an installation on a 225,000 lb. per hour capacity boiler. A third set of chart records show that the level on a boiler with a fluctuating load varies less than four inches total variation. The load fluctuates from 90,000 to 150,000 lb. per hour.

Fish-Schurman Corporation, 230 East 45th Street, New York 17, New York, has announced the publication of a new bulletin, DT 319, describing the sintered steel bonded diamond wheels, thin-walled.

The bulletin includes an illustration of "Steelset" and describes the various characteristics attributed to it, together with a cross-section view and a listing of stock sizes.

It is stated that sintered tools have many applications in the industrial and commercial glass fields and that they can also be used for cutting tubing, drilling holes (utilizing the slugs after the plate has been cut), bevelling, edging of glass, ceramics, granite and sapphire, including tungsten carbide.

Pittsburgh Plate Glass Company, Department G-6554, 632 Duquesne Way, Pittsburgh 22, Pa., is offering a new 20-page booklet entitled, "Carrara — The Modern Structural Glass of Infinite Possibilities".

In four sections, the booklet demonstrates the use of Carrara glass in 1) public buildings such as schools, civic centers, hospitals and libraries; 2) commercial buildings including offices, stores, hotels and theatres; 3) laboratories, process rooms and special applications in industrial buildings; and 4) homes and apartments. Recommendations, specifications and physical characteristics of the structural glass are also presented.

THE FIGHT AGAINST WASTAGE OF HEAT IN GLASS FURNACES . . .

(*Continued from page* 177)

(let us suppose the temperature is 27° C.); and that of the center of the furnace, t_0, which determines the melting (let us suppose this is 1450° C.). As a standard, let us begin with a clay block one foot thick whose average conductivity between 1450° and 250° C. (which we shall assume to be the temperature of its outside face) is:

$$K = 0.0125\ W/cm/^\circ C.$$

The fitting of the rectangle defines an external temperature $T_2 = 250°$; an internal temperature $T_1 = 1380°$; and a loss of 4.7 kilowatts per square meter, a value close to that measured directly. This is the theoretical example that we had chosen previously.

The table below (Table I) gives the average values of the thermal conductivity at a given temperature for various refractories used in glass making. Between two temperatures it is sufficiently accurate to take the arithmetical mean or to interpolate by means of a straight line law.

Experience over a period of time shows that, used under these conditions, clay blocks wear out rapidly. Their thickness diminishes so that tan α $(= K/e)$ increases; the rectangle in the graph becomes taller; which implies a rise in the external surface temperature, an increase in heat losses but a diminution of internal temperature.[4] It is a consequence of this reduction of temperature that the corrosion diminishes; the flux block wears away less and less quickly.

Every lowering of the temperature at the contact between glass and refractory will thus favor the life of the block. One of the principal reasons for the excellent durability of cast blocks—such as Corhart, whose reputation is now established—is the fact that their thermal conductivity is 2.7 times as high as that of ordinary clay block. The rectangle in the graph for these blocks is taller, and its fitting into place provides the following thermal characteristics:

Losses: 10 kW/m²
External Temperature: 350° C. (approx.)
Internal Temperature: 1250° C.

This last temperature is lower by more than 100° than that to which the ordinary clay block is submitted, and the attack by the glass is very feeble.

But it is quite possible to obtain a corresponding reduction of temperature, or a greater one, by blowing air on the blocks. In place of the curve which relates to radiation and free convection, we now have a bundle of curves dealing with radiation and forced convection for different speeds of draft. The curve Γ rises; and the fitting of the rectangle representing the block determines new heat losses, naturally increased ones, and involves a lowering of temperature both internally and externally.

Let us suppose, on the other hand, that we have insulated the flux blocks. The rectangle representing the sidewall of the tank is now broken into two parts: one representing the refractory and retaining the old characteristic angle α; the other representing the insulation and characterized by another angle β. The complete rectangle is very flat and its fitting indicates reduced heat losses, a lowered external temperature, but a higher internal one. In the case of the sort of block that we took as our starting point, the installation of a layer of insulating brick (Keiselguhr of K = 0.004, at an average temperature of 500° C.) 4¾ inches thick, gives us the following figures:

Losses: 2.1 kW/m²
T_1 : 120° C.
T_2 : 1420° C.

In addition, the diagram gives us the temperature at the inner face of the insulation, in this case 850° C.

It is evident that while the saving of heat is important (more than half), the refractory at 1420° C. is not going to stand up very well to the corrosion. If we were working at lower temperatures, the installation of the Kieselguhr would, on the contrary, be indicated.

Similarly, the ill-considered application of measures of economy such as outlawing molten-cast refractories of high conductivity, or of cooling air, the excessive use of insulation, etc., risks going in the opposite direction for the end that is sought, if the run must be shortened as a consequence of premature wear.

TABLE I

MEAN VALUES OF CONDUCTIVITIES

	Corhart K		Silica K		Clay K		Insulating Brick K	
	CGS	W/cm/°C	CGS	W/cm/°C	CGS	W/cm/°C	CGS	W/cm/°C
200°	0.0063	0.026	0.0025	0.010	0.0020	0.0084	0.0007	0.0028
600°	0.0080	0.033	0.0035	0.015	0.0030	0.0125	0.0010	0.0042
1000°	0.0095	0.040	0.0045	0.019	0.0033	0.014	0.0013	0.0055
1400°	0.0105	0.044	0.0054	0.023	0.0040	0.017	0.0018	0.0075

Note: In texts in the English language, K is often given in BTU per square foot per hour per °F per inch of thickness. Dividing the English figure by 2903 gives the value of K in CGS units. (Translator's note: i.e., in gram-calories per square centimeter per second per °C per centimeter of thickness. Since a watt is a joule per second, and a calorie is 4.2 joules, or 4.2×10^7 ergs, the second set of figures in Dr. Peyches' table is simply 4.2 times the first set.)

It thus seems that there is an incompatibility between saving heat and getting a long life from the furnace.

We shall partly remove this incompatibility by introducing the idea of *uniform wear*.

A furnace comes to a stop because certain parts are worn out while others remain intact. We may say that any part that is insufficiently worn is amenable to some action on our part looking to economizing on heat.

Sometimes cooling air is applied in an undiscriminating manner. What purpose does it serve to cool part of the furnace if, even in the absence of cooling, the wear on that part would still be trifling? Why not insulate a zone if, even after insulation is applied, the wear on that zone would still be insignificant? It simply means a useless waste of heat, if we do not insulate.

The glass maker always hesitates to insulate a furnace, because he fears the glass may seep or drill through. This comes about simply because in the absence of any exact information, he does not know where to apply his insulation, and in particular, how much of it to use. Perhaps it is also because certain experiments, badly devised, have produced accidents and caused a prejudice against these practices.

We may postulate—a little arbitrarily—that a refractory whose surface of contact with the glass does not exceed 1300° C. will not show more than a moderate

(*Continued on page* 194)

4. There results therefrom an increase in the thickness λ of the frozen film of glass. As a first approximation we shall nonetheless retain the same curve Δ.

Unretouched photo—ports are blocked with canvas to exclude drafts during examination.

EXCELLENT OPERATION PLUS GOOD REFRACTORIES...

OPERATING DATA	
Melting Area, Not Including Doghouse (Sq. Ft.)	518.5
Tank Depth, Metal Line (Inches)	34
Total Days Life	1150.0
Total Operating Days	1089.8
Total Idle Days	60.2
Tons Glass Delivered	114,103.1
Tons Glass Per Operating Day	104.7
Sq. Ft. Melting Area Per Ton Glass Per Day	4.95
Tons Per Square Foot Per Life	220.0

THE furnace shown above has just finished a campaign of 1089.8 operating days, producing 220.0 tons of amber bottle glass per square foot of melting area during the campaign! (Rate of pull — 4.95 sq. ft. per ton per day.)

Superior glass-production records are primarily the result of superior operational techniques. This example is no exception. But it goes without saying that the operators are pleased with the performance of the Corhart Standard Electrocast with which the furnace was built — and we of Corhart* are pleased that these operators have been consistent users of Corhart Electrocast Refractories for many years.

Corhart Refractories Company, *Incorporated*
16th and Lee Streets, Louisville 10, Kentucky
In Europe: L'Electro Refractaire, Paris.

*Not a product, but a trade mark.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

(*Continued from page* 192)

wear after a normal run. This temperature delimits on our diagram a dangerous zone (Fig. 7).

A typical point such as A, situated in this zone, must be drawn back into the safe zone, under penalty of premature wear. We may deduce the cooling air which is just needed to obtain this result.

Any point on the graph situated in the safe zone is amenable to insulation. We may deduce from the diagram the thickness that may be given to it.

Thus managed, the furnace will arrive at the end of its run without the latter having been shortened. It will no doubt be more worn—which will involve a more extensive repair—but it will have been at the same time more economical throughout the length of the run.

Economy of fuel is clearly a national duty, but this would be easier to accomplish if the glass man found therein a simultaneous pecuniary benefit. Is this the case?

The application of insulation to a square meter of tank sidewall, using clay blocks, will save around 2.5 kilowatts or say, in the course of a run lasting three hundred days, 18,000 kilowatt hours. This represents, in coal fed to the gas producer,[5] around three tonnes which, at a price of 1700 francs per tonne, means a money saving of 5100 francs.

If the application of this insulation has involved, on the other hand, such a corrosion of the blocks that they must be changed, the weight of refractories to be changed is around 0.6 tonnes per square meter. However, a good clay refractory costs, placed in position, around 13,000 francs per tonne. The increased expense, therefore, is around 7,800 francs.

In the eyes of the glass manufacturer, the operation does not begin to justify itself unless the insulated block fails to wear out as much as one and a half times as fast as the uninsulated one.

The conclusion, on the other hand, is wholly on the side of using insulation when we deal with electrical energy, since the saving of power would involve 18,000 francs if the cost of a kilowatt hour is one franc.

It is evidently impossible for us to examine all the cases that may present themselves in practice. We have simply tried to show by the above examples how the problem of saving fuel can be taken in hand by relying on exact numerical bases.

At the same time we have shown that this problem cannot be dissociated from that of the life of the furnace and the cost of repairs. We wish simply to suggest that glass makers themselves reconsider their installations. Even in the absence of measurements, he who knows the sensitive points and the points of minimum wear in his furnace will be able to act intelligently, provided that he also acts circumspectly. It will be by trial and error that he will succeed in determining the place and amount of permissible insulation. We ought not to be surprised if, while changes are being made to the tank, there appear heterogeneities in the glass, with distressing results on manufacture. These heterogeneities are due to the establishment of new regimes of internal convection, bringing back into circulation glass that had been stagnant in corners or on the bottom. The phenomenon can be avoided by making the changes very gradually: and, at the worst, it is very temporary.

It goes without saying that what we have just seen in some detail for the tank proper could be developed in a parallel manner for the roof or for any other part of the installation with important heat losses. All that is necessary is to use a little common sense so as not to find oneself fooling with trifles.* All one's efforts should be applied to the points of major loss. The others can be neglected, for the savings realized would not often pay for the expense incurred.

To illustrate this point, we may cite measurements we made on passages and arches which had been recently painted with aluminum paint, with the idea of reducing their emissivity.

The internal temperature was fixed: it was about $T_0 = 600°$ C. Experiment gave us an external temperature on the oxidized and blackened metal of $T = 134°$ C. (its emissivity being 0.8), which corresponds to a loss of 1540 kilocalories per square meter per hour. The painted surface has an emissivity of $\epsilon' = 0.6$: it took on a temperature slightly higher, $T' = 143°$, the chilling by radiation being a trifle less, but the convection losses rising slightly. Losses fell to 1510 kilocalories.

If the flux blocks had been perfect black-body radiators ($\epsilon_0 = 1$), the temperature on the outside would have been 125° C. and the losses 1560 kilocalories. So between emissivities of 1.0 and 0.6, the savings were only 3 per cent. In the long run it is possible that the cost of the paint might have been amortized, if the dust of the furnace room had not, within a few days, settled on it and raised the emissivity to its original figure of 0.8!

For higher surface temperatures, where radiation plays the preponderant role, the results will clearly be quite otherwise.

To summarize and conclude this first section, let us say then that as a rule the bottom blocks and at least the lower layer of sidewall blocks of the melting end are amenable to insulation. Likewise the working end in its entirety: but since the glass will now run too hot, it will be necessary to build up the shadow wall between the two ends. It may be necessary to modify the dimensions of the throat, or the depth of the floaters. The roof of the working end can certainly be insulated, as well as the last few courses of the roof of the melting end, perhaps away from points exposed directly to the flames. The silica sidewalls waste a lot of heat in most cases, and it should be similarly possible to insulate them.

This program, which deals circumspectly with the flux-line, the throat, and the end walls, applied to our type of furnace, ought to produce a saving of 200 kilowatts, or, during a run of 300 days, a saving of coal at the producer in the neighborhood of 250 tons.**

Since this involves only the furnace proper, it may be seen that we are dealing with savings by no means negligible, which deserve that we study the question in a little more detail. Let us not forget that the English glass makers, pressed by the necessities of war, managed to cut their furnaces' coal consumption by 20 to 30 per cent, which ought to convince us (in France) of the thoroughly practical character of such studies.

5. One may figure that each unit of additional heat loss from the furnace involves the use of an additional one and one-half units of coal in the producer.

*Translator's note: In French, "to fall into the saving of candle-ends."

**Translator's note: There have been some sad experiences in America from trying it.

America's Newest
MERCHANDISE SENSATION

"Sizzy" "Puzzy"

GLASS, like metal, proves Decal durability... adhesion!

WOOD-backed brushes sell better with color!

SOAP! A specialized Decal use! Like leather or leatherette!

PLASTIC application is no problem with Meyercord Decals!

Juvenile "Good Habit" Kits Colorfully Identified With

MEYERCORD DECALS

What versatility! Meyercord Decorative Decals even on soap! "Sizzy" and "Puzzy" are exclusive patterns, but hundreds of stock designs are now available for immediate delivery. They're durable, wear-resistant, economical—easily applied on practically any commercial surface. Give your products new "eye-appeal" with Meyercord Decorative Decals . . . providing hand-painted effects in choice of colors, size and design, large or small!

Send for FREE Catalog! You are also invited to submit product samples. Counsel free! Address Dept. 20-3

Cleverly designed Meyercord Decals help *sell* through window-type boxes featured by the House of Puzzy, Inc., Baltimore, Md.

The MEYERCORD Co.
5323 WEST LAKE STREET
CHICAGO 44, ILLINOIS

World's Largest Decalcomania Manufacturer

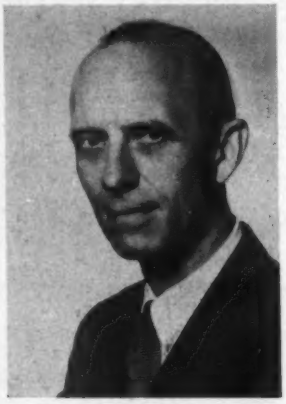
SIXTEN WOLLMAR SUCCEEDS F. GOODWIN SMITH AS PRESIDENT OF H-E

F. Goodwin Smith, President of the Hartford-Empire Company since 1927, has retired from that post and has been elected Chairman of the Board of Directors, according to a recent announcement.

F. Goodwin Smith

Sixten F. Wollmar, Vice President, has been elected to succeed Mr. Smith as President of the company.

Mr. Smith has been with the company for 32 years; first as General Manager, then as Vice President until his elevation to the presidency 20 years ago. When Mr. Smith first joined the company in 1915, its glass-making machinery was just being developed and not until 1917 did the company receive its first dollar of income. During the subsequent three decades, the company has achieved world prominence as the leading developer and manufacturer of machinery for making and handling glass containers.



Sixten F. Wollmar

Before coming to Hartford-Empire Company, Mr. Wollmar was Executive Vice President and a Director of SKF Industries, Inc., a post which he held through the high-production war years. Educated at Columbia University and abroad, he is a graduate engineer who served as President of SKF Steel Company until he became operating head of SKF Industries, Inc.

AMERICAN GLASSWARE ASSOCIATION PRESENTS ADDITIONAL DATA ON MAINTAINING TARIFFS

In a letter to Winthrop Brown, Chief of Commercial Policy, State Department, the American Glassware Association submits evidence of Czechoslovakian glass activity quoting from the *Czechoslovak Glass Review.*

On the strength of this, in a letter to J. Mark Albertson, Chief of the Ceramics Section, United States Tariff Commission, the A.G.A. maintains that in view of the facts as recorded by the Czechs themselves, they can see no justification for even considering the reduction of tariffs on hand-made glassware in the pending trade agreements negotiations in Geneva.

The U. S. glassware manufacturers are not nationalized and have already begun to feel a decline in the purchase of their ware in this country. U. S. glassware cannot be exported to the markets of the world because of price. The industry has been intermittently shut down during the last two months for lack of fuel and already are receiving indications that an increase in wages may be asked for by employees at the annual labor conference.

H. H. Guettrich

J. J. Smith

BALL BROTHERS NAMES ARIDOR STAFF MEMBERS

Ball Brothers Company has announced the appointment of H. H. Guettrich as Assistant General Manager and Sales Manager of its closure manufacturing division, The Aridor Company.

Associated with Mr. Guettrich in the operation of The Aridor Company will be B. M. Clark, Production Manager and Purchasing Agent; J. J. Smith, Production Superintendent; J. W. Pearce, Office Manager; and C. W. Patt, Sales Service Department.

N. Y. METROPOLITAN A.C.S. SECTION MEETS

The New York Metropolitan Section of the American Ceramic Society held a February meeting at which Dr. Francis J. Williams, National Lead Company, introduced Wm. J. Naven, Patent Attorney for Western Electric, who gave a talk on "The Function of Patents in the Ceramic Field".

It was also announced that the annual meeting of the Section would be held in May, probably the 23rd, at which time new officers for the succeeding year would be elected. Frank Fallon was appointed Chairman of the nominating committee to present a slate for the elections.

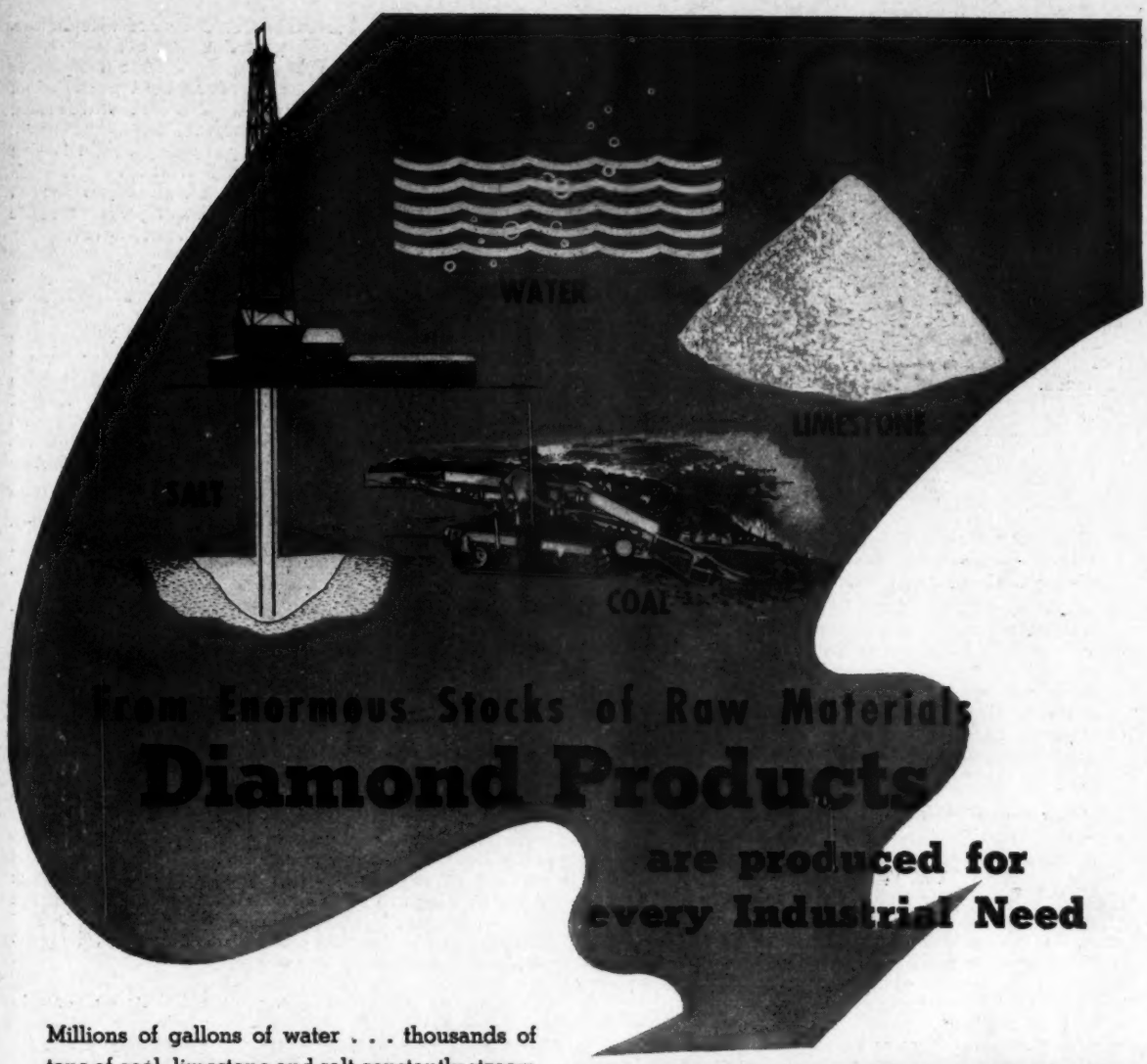
SHORT COURSE PLANNED IN STATISTICAL QUALITY CONTROL

An advanced eight-day course in Quality Control by Statistical Methods is to be presented June 27 through July 5 at Purdue University, Lafayette, Indiana.

The course will be under the leadership of I. W. Burr of the university and other instructors will be Edwin G. Olds of Carnegie Institute of Technology, Lloyd A. Knowler, University of Iowa, and Mason E. Westcott, Northwestern University.

All subject matter in the course will be simplified as much as possible. Topics will include background of control charts, significance of differences, analysis of variance, linear and multiple correlation, sequential analysis and other sampling and use of calculating machines. The presentation of the characteristics and applications of these statistical tools will be helpful to many of those who are now using statistical quality control.

• The Kimble Glass Company, a recently acquired subsidiary corporation of Owens-Illinois Glass Company, will be operated as the Kimble Glass Division of Owens-Illinois Glass Company. General offices will be maintained at Vineland, New Jersey.



From Enormous Stocks of Raw Materials

Diamond Products

are produced for every Industrial Need

Millions of gallons of water . . . thousands of tons of coal, limestone and salt constantly stream into *Diamond's* plants, and are continually being processed into alkalies and chemicals to meet industry's ever-increasing demands.

Diamond's plants and facilities are constantly being expanded and improved to handle even greater quantities of these raw materials, so that we may continue to merit and enjoy the confidence placed in us, and to supply industry's needs for the highest quality Diamond Products.

- SODA ASH
- CAUSTIC SODA
- BICARBONATE OF SODA
- SILICATE OF SODA
- LIQUID CHLORINE
- CARBON TETRACHLORIDE
- CALCIUM CARBONATES
- SPECIAL ALKALIES

(*Continued from page* 179)

Low-melting alkali-borate and alkali-phosphate glasses, containing a minor addition of colorant, were electrolyzed using voltages up to 10 volts. In the case of chromium, for example, the equilibrium could be shifted to the yellow Cr^{6+} ion in the anode portion and to the green Cr^{3+} in the cathode portion. Similarly, the iron equilibrium was displaced toward the Fe^{3+} ion or to the Fe^{2+} ion and to the metal. Among other examples, it was possible to produce yellow cadmium-sulfide glasses as well as the selenium ruby by means of cathodic reduction of cadmium glasses containing sulfates and selenites.

This electrolytic method has proved a useful laboratory tool for producing colored glasses in different states of oxidation.

Wednesday Afternoon, April 23, 1947

2:30 P.M.-5:30 P.M.

Convention Hall

9. Pyrometry for the Glass Industry and Introduction to Principles of Automatic Control. *By V. L. Parsegian: Tagliabue Division, Portable Products Company, Brooklyn, N. Y.*

Accurate measurement and control of temperature is as difficult as it is important to the glass industry. Whether in connection with thermocouples and potentiometers or total radiation and optical pyrometers, one must become error-conscious to obtain best results from expensive pyrometric equipment. Recommended practices and sources of error in temperature measurement are discussed at length, together with a very brief review of controller types.

10. New Tool of Heat-Flow Research in the Glass Industry. *By Victor Paschkis: Department of Mechanical Engineering, Heat and Mass Flow Analyzer Laboratory, Columbia University, New York 27, N. Y.*

Problems of temperature fields and rates of heat flow in glass and ceramics can be conveniently investigated by means of electric analogy. The method is predicated on the identity of the different equations for heat flow in a solid and for electric current in a body with evenly distributed resistivity and capacity. In order to carry out the method, the body in which heat flow occurs is considered to be divided into sections or lumps.

The method has been applied to a large number of problems in various fields, and several such problems are briefly discussed in the paper. Examples include the solidification of ingots and castings, temperature loss from intermittently operated furnace walls, influence of through-metal on the insulating value of thermal insulation, and others.

Some heat-flow problems in the manufacture of glass and ceramics are listed, and experiments are described which have been carried out for two problems in the glass industry, namely, (1) the temperature distribution in the rolls used in plate-glass manufacture and (2) the temperature gradients in an electrically heated airplane window with wires embedded between glass and plastic.

Thursday Afternoon, April 24, 1947

2:30 P.M.-5:30 P.M.

Convention Hall

11. Surface Tension in PbO-B_2O_3 System. *By L. Shartsis, A. W. Smock, and S. Spinner: National Bureau of Standards, Washington 25, D. C.*

The surface tension of members of the PbO–B_2O_3 system ranging in composition from 0 to 100% PbO was measured by a maximum pull-on-cylinder method. From about 5 to 40% PbO the surface tension at 900°C. was almost constant at about 78 to 80 dynes per cm. As the percentage of PbO was further increased, the surface tension rose to a peak volume of around 163 dynes per cm. at about 80 to 84%. Above 84% PbO, the surface tension decreased with increasing PbO until the value for pure PbO was obtained.

The temperature coefficient of surface tension was positive from 0 to 47% PbO, became negative from there to about 82%, and positive again above 82%. The coefficient reached its maximum negative value around 61% PbO.

The volatility of the system, as judged by weight loss on heating, showed a distinct minimum at about 80 to 84% PbO. Below these percentages chemical analysis showed that more PbO than B_2O_3 was lost on heating whereas above these percentages the reverse behavior was observed.

12. Surface Tension in the PbO-SiO_2 System. *By L. Shartsis and S. Spinner: National Bureau of Standards, Washington 25, D. C.*

The surface tension of members of the PbO–SiO_2 system ranging in composition from 0 to 35% SiO_2 was measured by a maximum pull-on-cylinder method. The surface tension rose smoothly from a value of about 137 dynes at 1100°C. for pure PbO to about 236 dynes for the 34.5% SiO_2 composition. The temperature coefficient of surface tension was positive for all the compositions measured, but its absolute value decreased as the percentage of SiO_2 increased.

13. Voltage Anomalies of the Glass Electrode and Chemical Durability of the Glass. *By Donald Hubbard and G. F. Rynders: National Bureau of Standards, Washington 25, D. C.*

Additional work has been done on the correspondence between voltage departures (errors) of electrodes prepared from Corning 015 glass and the change in the chemical durability of the glass. The results obtained by the interferometer method confirm and extend the earlier findings that in every case voltage departures on the electrode are accompanied by durability changes in the glass. Dilute solutions of acids that do not form soluble compounds of silica cause swelling of the glass, which swelling is repressed as the concentration of the solution is increased. As is to be expected from the distribution law and Donnan membrane considerations, this repression of swelling was also brought about by high concentrations of organic acids and salts as well as by the so-called "strong" acids. The attack of the Corning 015 glass by alkaline solutions by different ions was found to be in the order of $Na^+ > Li^+ > K^+ > Ba^{++} > NH_4^+$ which is the same order dictated by the voltage-departure data for these ions.

14. Study of Time and Temperature Effects on Glass in Annealing Range. *By P. W. Collyer: Scientific Instrument Division, American Optical Company, Buffalo 15, N. Y.*

Samples of a melt of borosilicate glass have been treated by holding them for periods up to 500 hours at constant temperature. The equilibrium was attained to a very close approximation at several temperatures. This nearness of approach makes possible the comparison of various proposed equations relating the rate of change of properties to their equilibrium values.

Refractive index was the characteristic used to indicate the rate of approach to equilibrium conditions. After it is shown that the equations expressing, dn/dt, as first or second degree functions of $(n_e - n)$ do not seem to fit the present data, the equation proposed by Tool is transformed to give equation (1) for the rate of change of index.

$$\frac{dn}{dt} = Q\,(n_e - n)\; e^{-\frac{n}{p}} \qquad (1)$$

$$O = MK_0\, e^{T/8}$$

t = time.
n = refractive index.
n_e = equilibrium value of n.
T = temperature.
p, M, K_0, g = constants.

It will be shown that this equation appears to represent adequately the changes of index derived from the present data and also those of previous investigators.

15. Reports of Subcommittee C-14 on Glass and Glass Products, American Society for Testing Materials.

(*Continued on page* 200)

2 WAYS

to approach a color problem

. . . see an astrologist OR ask Drakenfeld to help

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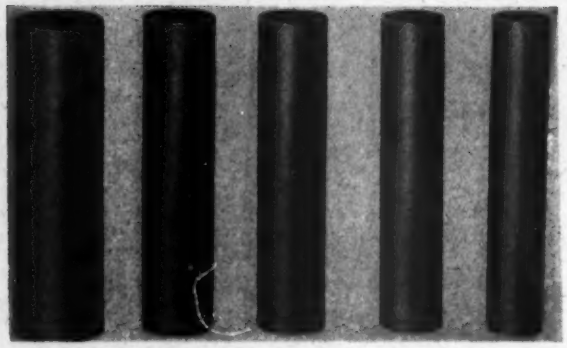
GUNITE
ROUND BAR STOCK



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Patterns are available in eighteen diameter sizes ranging from ¾" to 5", all bars are 14 inches long.

Gunite has proven to be of ideal hardness for glasshouse work. The metal can be machined with relative ease, yet retaining sufficient density to afford a brilliant polish.

There is a suitable Gunite Alloy for each type of glass making part such as Plungers, Guide Rings, Neck Ring Sticks, etc.

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GUNITE
FOUNDRIES CORPORATION
ROCKFORD ILLINOIS
Established 1854

A. C. S. ANNUAL MEETING . . .

(*Continued from page* 198)

Advisory Committee: Louis Navias, *Chairman;* U. E. Bowes, C. E. Heussner, J. C. Hostetter, J. T. Littleton, S. R. Scholes, and E. W. Tillotson.

I. Nomenclature and Definitions: F. C. Flint, *Chairman;* James Bailey, W. M. Clark, J. C. Hostetter, G. W. Morey, S. R. Scholes, and F. J. Williams.

II. Chemical Analysis: G. E. F. Lundell, *Chairman;* W. R. Lester, D. C. Smith, W. C. Taylor, and P. A. Webster.

III. Chemical Properties: J. F. Greene, *Chairman;* O. G. Burch, F. C. Flint, Merle Hagemeyer, C. H. Hahner, C. E. Heussner, F. L. Jones, C. W. Kendall, W. R. Lester, G. E. F. Lundell, Joseph Majeske, H. R. Moulton, J. L. Powers, D. D. Schurtz, D. E. Sharp, A. L. Simison, W. C. Taylor, and R. W. Wampler.

IV. Physical and Mechanical Properties: J. T. Littleton, *Chairman;* U. E. Bowes, J. S. Gregorius, C. H. Hahner, W. R. Koch, Louis Navias, C. W. Parmelee, V. L. Plagge, F. W. Preston, A. B. Scholes, S. R. Scholes, N. W. Taylor, and H. A. Wadman.

V. Thermal Properties: E. W. Tillotson, *Chairman;* U. E. Bowes, L. K. Jones, H. K. Richardson, M. S. Van Dusen, H. A. Wadman, J. H. Waggoner, and R. W. Wampler.

VI. Glass Construction Block and Tile: J. C. Kohl, *Chairman;* U. E. Bowes, Theodore I. Coe, R. B. Crepps, L. K. Jones, G. P. Keogh, Albert S. Low, and W. F. Spikes.

VII. Glass Containers: K. C. Lyon, *Chairman;* R. F. Brenner, F. C. Flint, L. G. Ghering, M. W. Green, J. F. Greene, Merle Hagemeyer, W. R. Lester, A. K. Lyle, S. R. Scholes, J. G. Shakman, D. E. Sharp, W. F. Spikes, E. W. Tillotson, and J. H. Toulouse.

VII. Glass Containers, Section A, Pharmaceutical Containers: F. C. Flint, *Chairman;* G. D. Beal, O. G. Burch, M. W. Green, J. F. Greene, C. H. Hahner, C. E. Leberknight, J. T. Littleton, K. C. Lyon, Joseph Majeske, P. T. Rees, W. J. Rice, D. E. Sharp, and E. W. Tillotson; *Consulting Member,* F. S. Brackett.

VIII. Flat Glass: D. E. Sharp, *Chairman;* A. S. Crandon, C. E. Heussner, G. M. Kline, J. H. Lewis, W. O. Lytle, J. D. Ryan, W. F. Spikes, E. W. Tillotson, and S. L. Windes.

16. Proposal for a Third International Glass Congress.

(*a*) Introduction of the subject by J. C. Hostetter.
(*b*) Presentation of the discussion by J. S. Gregorius and H. H. Blau.
(*c*) Summary by S. R. Scholes.
(*d*) Discussion from the floor.

17. Properties of Soda-Strontium Oxide-Alumina-Silica Glasses. *By C. L. Babcock: General Research Laboratory, Owens-Illinois Glass Company, Toledo, Ohio.*

Data are presented on the properties of twenty-seven Na_2O SrO Al_2O_3 SiO_2 glasses covering the following percentage composition ranges: SiO_2 66 to 78; SrO 4 to 16; Al_2O_3 0, 2, and 4; and Na_2O 14, 15.5, and 17. The effects of the systematic substitution of SrO for SiO_2, Al_2O_3, and Na_2O are shown for liquidus temperature, viscosity, coefficient of expansion, deformation temperature, density, and resistance to dilute acid and distilled water.

18. Effect of Boric Oxide on Properties of Soda-Dolomite Lime-Silica Glass. *By J. C. Coleman: General Research Laboratory, Owens-Illinois Glass Company, Toledo, Ohio.*

In two base glasses, the first containing 16% of sodium oxide, 10% of dolomite lime, and 74% of silica, and the second with 14% of sodium oxide, 12% of dolomite lime and 74% of silica, boric oxide was systematically substituted for (*a*) Na_2O, (*b*) CaO MgO, and (*c*) SiO_2 in amounts of 1, 3, and 5%. The effects of these substitutions on such properties as liquidus temperature, viscosity, deformation temperature, fiber-softening point, coefficient of expansion, and the resistance of the glasses to dilute acid and distilled water are presented.

19. Attack of Glasses by Alkaline Solutions. *By R. D. Smith and P. E. Corbin: Corning Glass Works, Corning, N. Y.*

(*Continued on page* 202)

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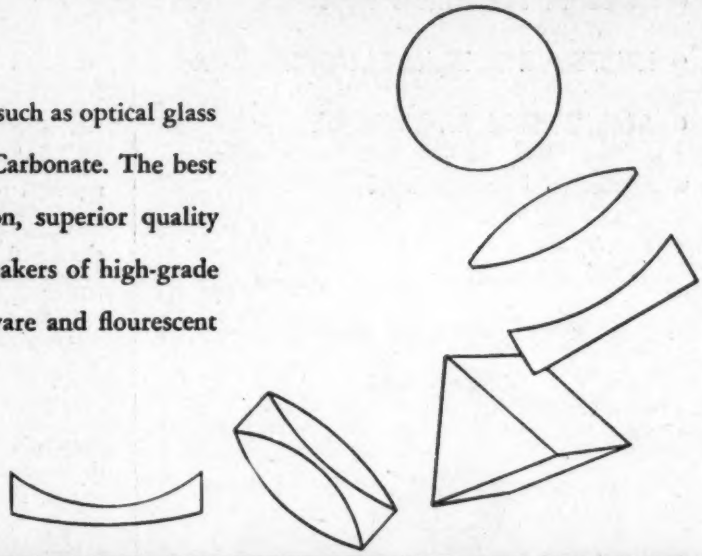

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A. C. S. ANNUAL MEETING . . .

(*Continued from page* 200)

20. Theory of Behavior of Glassware in Service. *By J. T. Glathart and F. W. Preston: Preston Laboratories, Butler, Pa.*

The most important characteristic of a piece of glassware such as a bottle or a jar is its serviceability, i.e., the amount of use which can be obtained from it. In the case of glassware which is subject to repeated re-use, this serviceability may be thought of in terms of length of life, measured either by months or years, if the service is uniform, or measured by the number of trips successfully undergone if it is not.

The termination of the serviceability of such glassware is due to breakage, and breakage in turn is, in the vast majority of cases, due to impact. But a piece of glassware may survive many severe impacts, only to succumb to a comparatively minor one. Impact alone is not the whole story. Glassware must be prepared for breakage by undergoing a process of use and abuse during which the surface is scratched, abraded, and otherwise damaged and thus rendered vulnerable to the final stroke.

In the present paper the assumption is made that in nearly all cases breakage involves two separate and independent processes, the "vulnerating" process and the final impact. On this assumption a mathematical treatment is evolved which yields a mortality curve showing the relation between the rate of breakage and the service age of a given installation of glassware. This curve has been found to represent quite accurately the results of a service test on glass tumblers conducted in an actual restaurant.

Impact strength, as determined by laboratory tests, declines with service age in a way consistent with the above assumption. These strength data, furthermore, may be correlated with the results of the service test.

Additional data are being secured from other service tests now in progress.

OWENS-CORNING TO ERECT CALIFORNIA PLANT

Owens-Corning Fiberglas Corporation has announced the purchase of a 42-acre plant site in Santa Clara, California, and plans to erect a Fiberglas factory there to supply western markets. The site is in the bay area about forty miles south of San Francisco.

Construction drawings for the plant to be erected on the site are being prepared under direction of Fiberglas engineers. It is estimated that at least six months will be required for this preliminary engineering work. No date for the start of construction has been announced, but the plant is being designed to provide approximately 500,000 square feet for manufacturing and warehousing.

Several hundred persons will be employed when the plant is ready to start operating and it is likely that the size of the employed group will eventually reach 1,000 when the facilities are completed, probably late in 1948. The plant's payroll is expected to reach an annual rate of $1,500,000.

LELAND HAZARD ELECTED TO PITTSBURGH PLATE BOARD OF DIRECTORS

Election of Leland Hazard to the Board of Directors of Pittsburgh Plate Glass Company was announced recently. Mr. Hazard succeeds Robert L. Clause, who recently resigned as a director.

After engaging in the general practice of law for many years, Mr. Hazard became Counsel for the company in October 1938. The following year, he was named General Counsel for the firm and was elected Vice President in 1944.

Easter Sunrise Services, Death Valley, California

At this time of the year, Death Valley bursts forth into a riot of blooms, filling the canyons and ugly scars of the mountain sides with a carpet of green, flecked with colorful wild flowers, if only for a few days, especially after an average rainfall. It's nature's resurrection in the Springtime and makes a fitting setting among the sand dunes with only the heavens as a canopy for the Easter Sunrise Services in commemoration of the Day of Resurrection.

Death Valley is far from any center of population, but folks come to attend the Easter Sunrise Services on foot, horseback, automobile and even by air in these modern times. Nearby Furnace Creek Inn is taxed to capacity and trailers move in from every direction. Many of the folks are direct descendants of the pioneer 49er's who survived the first crossing of the desert, adding to the solemnity of the occasion.

GOOD COLOR

In glass container ware good color is an outstanding and desirable characteristic. The appearance of the ware is improved and the contents displayed to better advantage. A small amount of Boric Oxide as a minor batch addition will produce a quicker melting glass, one requiring small amounts of decolorizer, consequently, a better color.

Another good reason why Borax should be used as an essential ingredient in the batch formula.

Our representatives are prepared to discuss the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX COMPANY

51 MADISON AVENUE, NEW YORK 10, N.Y.

INVENTIONS & INVENTORS . . .
(*Continued from page* 186)

the moile from the tumbler and the flame is reduced in temperature so as to form a bead on the edge of the tumbler. The bottom plate is then lowered, the suction is cut off and the finished tumbler is removed.

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	*Name*	*Date*
610,588	Schrader	Sept. 13, 1898
2,215,980	Schreiber	Sept. 24, 1940
2,239,627	Schutz	Apr. 22, 1941
1,996,814	Kadow	Apr. 9, 1935
1,577,536	Parker et al.	Mar. 23, 1926
1,757,211	Parker	May 6, 1930
1,577,538	Parker	Mar. 23, 1926
1,577,655	Parker	Mar. 23, 1926

Corhart Cast Refractory. Patent No. 2,416,472 is on a cast refractory invented by Theodore E. Field and assigned to Corhart Refractories Company. This invention relates to heat cast refractories and this is to be understood to mean a melting process such as shown in Patent No. 1,615,750 to Fulcher.

Refractories, in accordance with this patent, consist of well developed interlocking crystal phases and an amorphous matrix. Mr. Field has made various improvements in refractories of this general type. The following table gives seven examples of compositions coming under this patent, these melts being made by melting pure oxide.

Melt	Chemical Compositions ZrO_2	MgO	Al_2O_3	Calculated Phases Spinel	Corundum	ZrO_2
A	20	10	70	35	45	20
B	30	20	50	70	0	30
C	30	10	60	35	35	30
D	40	17	43	60	0	40
E	40	10	50	35	25	40
F	50	10	40	35	15	50
G	60	10	30	35	5	60

Other examples of batch compositions are:

Melt	ZrO_2	MgO	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	CaO	Na_2O
H	10.0	10.0	77.7	1.3	0.6	0.2	0.2	0.0
J	10.5	10.4	69.8	9.0	0.1	0.0	0.2	0.0
K	13.4	13.3	63.2	5.0	2.5	2.1	0.5	0.0
L	13.9	21.0	55.8	4.5	2.3	1.9	0.6	0.0
M	20.0	20.3	51.8	4.6	1.1	0.3	0.5	1.4
N	31.1	16.4	44.7	5.1	1.7	0.4	0.4	0.2
O	41.9	12.8	34.6	7.5	1.1	1.6	0.5	0.0
P	53.8	10.1	30.0	3.9	0.6	0.3	0.2	1.1

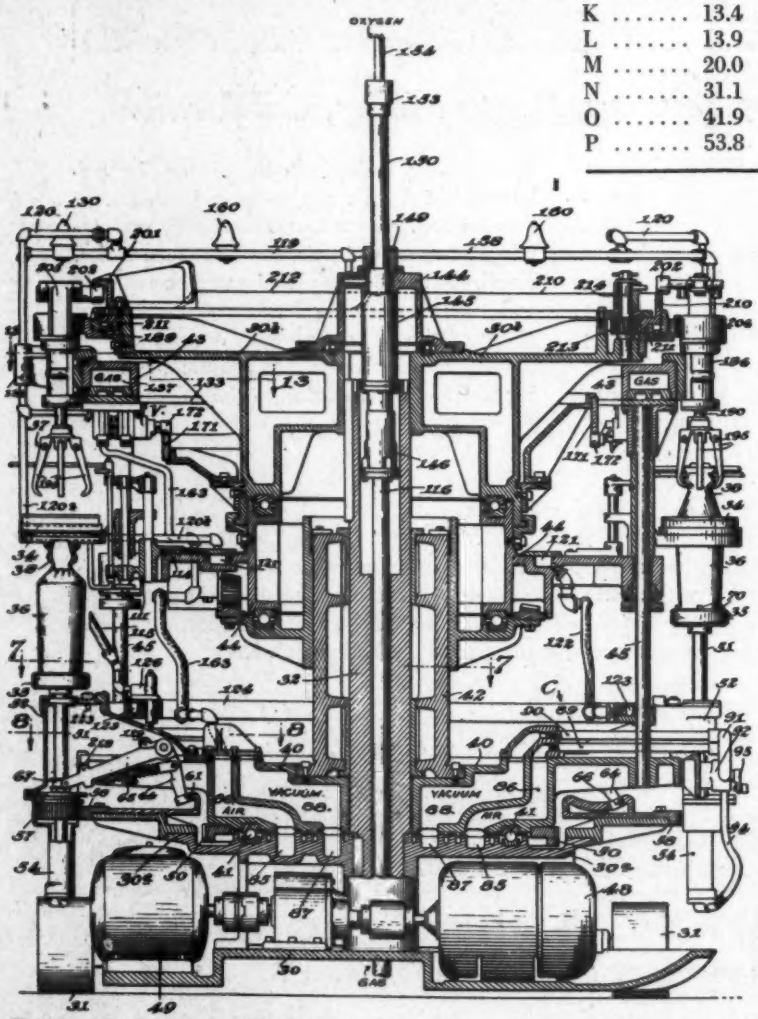

Fig. 7. Owens Burn-off Machine.

The following references are of record in the file of this patent:

UNITED STATES PATENTS: 2,271,366, Field, Jan. 27, 1942; 2,271,369, Fulcher et al., Jan. 27, 1942.

Method of Tempering Sheet Glass. Fig. 8. Patent No. 2,417,904 is on a method of tempering sheet glass and it was issued to Arthur E. Spinasse of Mount Vernon, Ohio. The patent provides for electrically heating the glass to about 1000 deg. F., which heating may be repeated at lower temperatures, and then rapidly cooling it. The invention is a continuation in part of an earlier patent to Spinasse, No. 2,197,811.

The simplest form of the invention is shown in Fig. 8, where a sheet of glass 1 is shown as being drawn from a bath of molten glass 2. The sheet is drawn upwardly by rolls 6 and is then engaged by asbestos belts 8 which are driven by rolls 10. These belts carry a series of heater strips 18 which are heated by electricity provided by contacts 21. Pressure rolls 15 assist in holding the heater strips against the glass.

(*Continued on page* 206)

UNION PACIFIC

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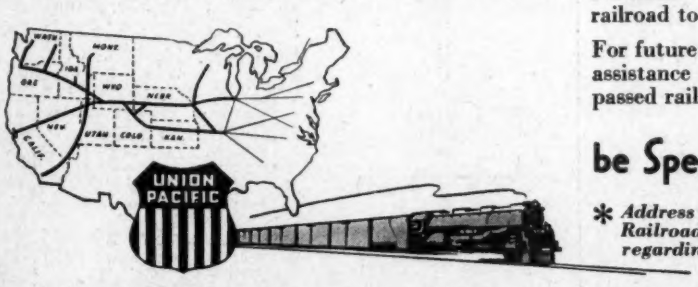

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Glass Batch
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A NEW SERIES OF SMALL RADIO TUBES . . .

(*Continued from page* 180)

rectly-heated cathode, and there is much less likelihood of oxidation of the tungsten during the sealing process.

The maintenance of close bulb dimensions by the glaze sealing method permits the fittings of a metal band with a stud to the lower part of the bulb, and this stud acts as the locating device when the tube is inserted into the socket. It is even possible to blow a slight protuberance in the bulb wall itself to act as a locating pin. The 9-pin tubes are made without bases, and the diameter is thus 20.5 mm.

The reduction in size which is possible by the glaze sealing technique is illustrated by Fig. 4, where four successive models of two different tube types, namely, an intermediate-frequency pentode and an output pentode with about the same performance, are shown side by side.

INVENTIONS & INVENTORS . . .

(*Continued from page* 204)

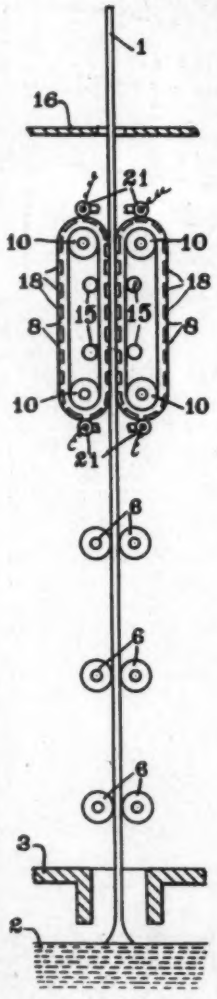


Fig. 8. Method of Tempering Sheet Glass.

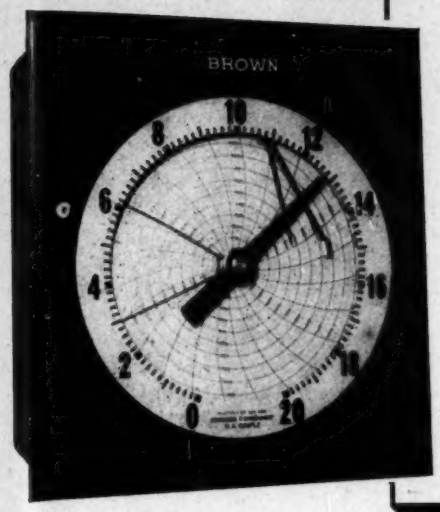
The sheet is cooled by atmosphere after leaving the heaters 18 or an air blast. The patent states that the tempered sheet is cut to the desired size at the point 16.

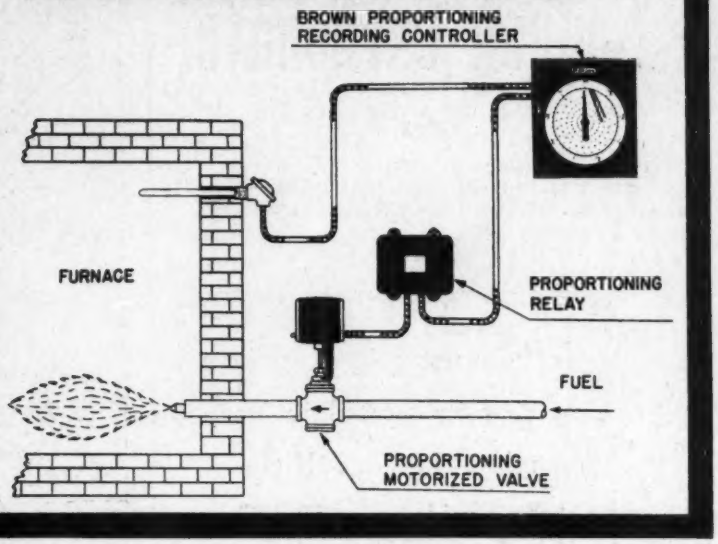
The patent shows several more complicated mechanisms all working on the principle of heating a series of narrow strips extending across the sheet.

The following references are of record in the file of this patent: UNITED STATES PATENTS: 820,205, Keighley, May 8, 1906; 876,267, Colburn, Jan. 7, 1908; 1,550,427, Corl, Aug. 18, 1925; 694,711, Anderson, Mar. 4, 1902; 1,887,414, LeRoy, Nov. 8, 1932; 1,266,625, Rau, May 21, 1918; 1,981,560, Littleton, Nov. 20, 1934; 2,009,748, Sherwood, July 30, 1935; 1,999,588, Fox, Apr. 30, 1935; 1,795,819, Axell, Mar. 10, 1931; 170,339, Brookfield, Nov. 23, 1875; 711,287, Colburn, Oct. 14, 1902; 720,517, Frink et al., Feb. 10, 1903; 1,413,766, Myers, Apr. 25, 1922; 2,197,811, Spinasse, Apr. 23, 1940; 1,420,181, Clark, June 20, 1922; 891,924, George et al., June 30, 1908; 1,480,625, Miller, Jan. 15, 1924; 985,866, Wadsworth, Mar. 7, 1911; 1,373,533, Slingluff, Apr. 5, 1921; 1,367,858, Campbell, Feb. 8, 1921; 363,087, Schreiber,

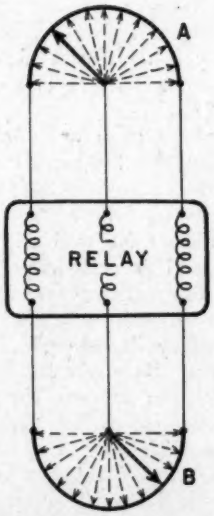
(*Continued on page* 208)

NOW available





PROPORTIONING CONTROL *plus* Continuous Balance



Proportioning Circuit (Pictorial). ElectroniK Proportioning Controller (A) connected to Proportioning Motor (B).

Now, all the advantages of electric proportioning control are enhanced by the greater accuracy, sensitivity and speed of response of the Brown ElectroniK Potentiometer.

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Natrona
ALKALI COMPANY
Room 9026 Du Pont Building
WILMINGTON (98), DELAWARE

INVENTIONS & INVENTORS . . .

(*Continued from page* 206)

May 17, 1887; 1,585,542, Henry, May 18, 1926; 2,177,324, Long, Oct. 24, 1939; 245,248, Weyer, Aug. 2, 1881; 877,729, Owens, Jan. 28, 1908; 900,281, Holmes, Oct. 6, 1908; 1,944,625, Ziegler, Jan. 23, 1934; 198,804, Luttges, Jan. 1, 1878; 1,586,897, Harris, June 1, 1926; 1,646,498, Seede, Oct. 25, 1927. FOREIGN PATENTS: 3,307, British, 1875; 816,096, French, Apr. 26, 1937; 25,925, British, 1911.

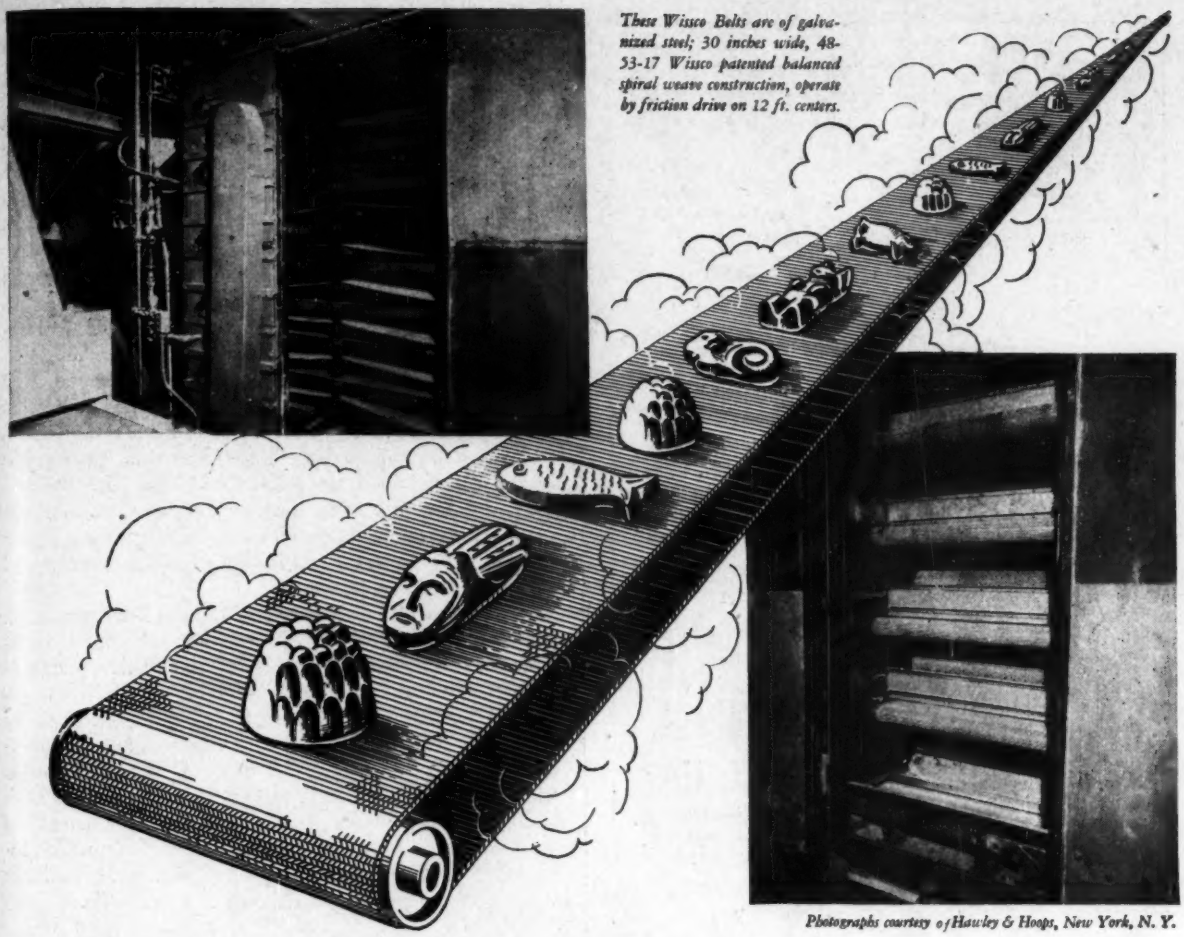
NEW RESEARCH INSTITUTE FORMED IN BELGIUM

A new research institution to serve the silicate industry of Belgium has recently been organized according to information furnished by Mr. A. Deschamps, who recently arrived in this country on an extended business trip. Mr. Deschamps is Director of Research of the firm Glass et Verres, "Glaver" of Brussels, Belgium, prominent manufacturers of plate and window glass and glass specialties.

The new institution, which has been named the "Institut Nationel du Verre" will be located in Charleroi, Belgium, and in many respects will provide Belgium the equivalent of what is furnished in Great Britain by the Glass Delegacy, and in France by the new Institut du Verre. The city of Charleroi has furnished a site for the erection of appropriate buildings and has provided the bulk of the funds for the main building program. It is expected that about half of the operating budget will be supplied by the glass and ceramic industries of Belgium and the balance by the well known Institut de Recherches Scientifiques Industrielles et Agricoles, "IRSIA", under whose patronage the new institution will be operated. An outstanding scientist has been persuaded to accept appointment to lead the research activity and steps are already under way toward selection of a staff. It is worthy of note that the studies planned by the new Institute will be mainly in the general field of silicate and thermal research and that all reports will be made public for the benefit of all.

Of particular interest to glass technologists in the United States is the fact that the magazine, "Verre et Silicates Industriels", which suspended operations during World War II, has resumed publication and becomes the official organ of the Institut Nationel du Verre. The first number of this journal since the war was published in December 1946 and copies are just reaching this country. This first issue contains articles on Oxidation-Reduction Reactions in Glass, by Professor P. Gilard; The Development of Technical Porcelain During the War, by Gertrude Bieler; Relation Between Thermal Expansion and the Alumina Content of Refractory Products, by Dr. Marcel Lepingle; The Origin of the National Commission of Craftsmen and Art Industries, by Henri Javaux; an anonymous article on Thermal Balance by Photographic Recording from the Lab. Union Verr. Mec. Belges, of Charleroi, and a brief article on the Economics of the Cement Industry by Dr. M. J. M. Jaspers.

The current issues are in the old format but due to the sponsorship by the new institute of the "Verre et Silicates Industriels", it is expected that the structure of the magazine will be changed from that of trade publication to the status of a true technical and scientific medium.



These Wissco Belts are of galvanized steel; 30 inches wide, 48-53-17 Wissco patented balanced spiral weave construction, operate by friction drive on 12 ft. centers.

Photographs courtesy of Hawley & Hoops, New York, N. Y.

These Wissco Belts Carry Candy Through a "Turkish Bath"

During operation, the doors of this steaming machine are closed and live steam removes the starch coating from molded, gum-arabic-base candies as they ride back and forth over 9 Wissco Conveyor Belts.

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ANNUAL MEETING OF THE OPTICAL SOCIETY . . .

(*Continued from page* 181)

cessive sets of diminishing thickness gradually cut out all but one passband as narrow as of the order of one angstrom.

The innovation shown at the meeting by B. H. Billings (Polaroid Corp.) in his talk on "Tunable Narrow Passband Optical Filters" was the tuning of the passband to variable wavelengths by flexible retardation filters based on (a) mechanical stretching of plastic filters or (b) electrical response of crystals of high electro-optical coefficients such as ammonium dihydrogen phosphate.

In photometry, colorimetry and color photography it is necessary to "translate" color sensitivities of instruments, eyes or films. The methods to calculate and control a problem of this type were illustrated for the case of the correction of the RCA photo tube No. 926 and tested by comparing the developed filter glass with the idealized curve by A. J. Werner, Corning Glass Works ("Correcting Filters for Photoelectric Photometry and Colorimetry").

Of fundamental, if indirect, relation to filters was I. H. Godlove's talk on "Colors Due to Ideal Absorption and Transmission Bands". The presentation is concerned with the interesting art of foreseeing colors from sysmatical variations of absorption bands ("strong or weak", "wide or narrow" and in different spectral position). The influence on color of equal variations varies widely with the spectral location. For instance, the shift of a band in the yellow by 10 mμ affects color more than a 50 mμ shift in the blue-green. The analysis of this interesting paper presupposes the publication of a large amount of the illustrations shown and indicated.

Sun Glasses

Apparently replying to the statement heard at a previous optical society meeting that little or nothing had been done regarding the systematic evaluation of sun glasses, Mr. E. L. Hettinger, of Wilson Products, Inc., recorded thirty years of experience in the "Spectral Transmission of Some Eye Protective Glasses", including the deliberate and accidental variations encountered in iron containing glasses.

General Topics

The volume and value of the presentations at the optical society has increased to such an extent that the reader of a glass magazine must be referred to forthcoming reports in regard to non-glass topics. By the way of illustration, an arbitrary selection of major events of various nature is summarized in the following lines.

The extension of spectrographic work high above the atmosphere of the earth by V-2 rockets has extended the range of radiation considered practical in chemical spectrographic analysis.* The chemistry of the universe will be explored, using the short wave lengths usually swallowed by our air shell. The use of infra-red analysis in chemical factory control has gained rapidly. The measurement of your eye will be made by non-irritating "infrared optometrists".** At the Inter Color Society

*Many authors from U.S. Naval Research Lab.
**Many papers from the laboratories of Perkin Elmer, Baird Ass., Dow Chemical, Bureau of Stand., U. of Michigan, Cyanamide, Cancer Research Inst., Canada's National Res. C., U. of Oklahoma, Westinghouse.

Meeting following that of the Optical Society, R. Evans of the Eastman Kodak Company took steps to suggest the addition of a fourth color variable (clear-diffuse) to those three now in use: (1) hue, (2) value (light-dark), (3) chroma (pure to gray).

Dr. Max Herzberger, of Eastman Kodak, and the eminent and charming spectrographer from Pittsburgh, Dr. Mary Warga, told of their scientific and personal experiences in Paris at a dinner meeting steered with humor and strength by Dr. Harrison. At this same dinner meeting many people could not be admitted in spite of the generous facilities. This was in part due to the advance interest in the revelation of the new photographic process developed by E. H. Land, president of Polaroid. In part, the increased and enthusiastic response to matters austere presented well to an audience including a large portion of the permanent female associates of scientists at home has its own significance.

NATIONAL SAFETY COUNCIL PUBLISHES SAFETY MANUAL

The product of two and a half years of research and preparation, a 544-page manual entitled "Accident Prevention Manual for Industrial Operations" has been published by the National Safety Council.

The manual contains 400 illustrations, charts and tabulations and is intended as a handy and authoritative source of accident prevention information for safety directors, safety engineers and foremen. Each of the fourteen major divisions of the book is preceded by a summarizing index for quick location of general topics, while a twelve-page alphabetical index at the back gives access to details.

The fourteen major subjects covered are: plant design and layout, construction and demolition, permanent equipment and facilities, guarding and operating machinery, materials handling and storage, electrical hazards, chemical hazards, fire and explosion hazards, flammable liquids, hand and portable power tools, commercial vehicle operation, personal protective equipment, industrial hygiene and safety organizations and programs.

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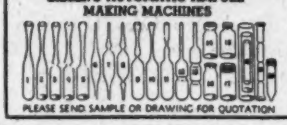

PLEASE SEND SAMPLE OR DRAWING FOR QUOTATION

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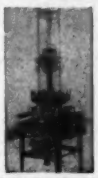

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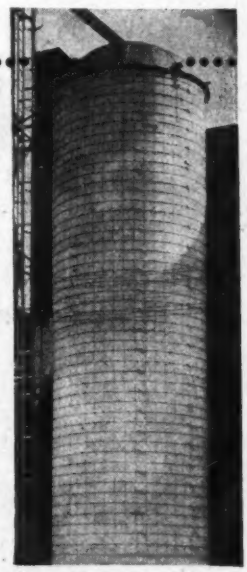

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